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SUPPLEMENT TO "A COMPILATION OF PHASE-RULE DIAGRAMS OF INTEREST TO THE CERAMIST AND SILICATE TECHNOLOGIST"

By F. P. Hall and Herbert Insley

Compiled and Published under the Auspices of the Fellows of the American Ceramic Society

Preface

The original "Compilation of Phase-Rule Diagrams" which was published as the October, 1933, issue of the *Journal of the American Ceramic Society* contained 178 diagrams. Of these, 159 pertained to specific systems. In the present supplement there are 154 diagrams, all of which pertain to specific systems. These include a few diagrams inadvertently omitted from the original compilation, the rest having been published since its appearance. The arrangement of the diagrams in the supplement follows that used in the original. An index has been added covering diagrams in both original and supplemental compilations.

No attempt has been made to evaluate the diagrams critically. Most of the diagrams follow the original as closely as possible, although in a few instances obvious mistakes in the original diagrams have been corrected. Molecular or weight per cent is used following the original diagram. When not specified the diagram is on the weight per cent basis.

LIST OF DIAGRAMS PUBLISHED OCTOBER, 1933

Part I. General Diagrams

Fig. *1*.—Phase relations in a one-component system.
Fig. *2*.—A two-component system without intermediate compounds or solid solutions.
Fig. *3*.—Variations in relative amounts of liquid and solid phases.
Fig. *4*.—Two-component systems with compounds present.
Fig. *5*.—Complete solid solution without maximum or minimum in a binary system.
Fig. *6*.—Binary systems with a single solid solution.
Fig. *7*.—Vapor pressure of component *A* in solid and liquid phases.
Fig. *8*.—Solid solutions showing conjugate relationships.
Fig. *9*.—Conjugate liquid phases.
Fig. *10*.—Six typical cases of three-component systems.
Fig. *11*.—Three-component system, CaO–Al_2O_3–SiO_2, showing boundary curves and composition lines.
Fig. *12*.—The course of crystallization in a ternary system.
Fig. *13*.—A ternary system with a binary compound of two components which does not form a binary system with the third component.
Fig. *14*.—A ternary system containing a binary compound unstable at its melting point.
Fig. *15*.—Recurrent crystallization in a ternary system.
Fig. *16*.—Diagrams of a three-component system in which one of the binary systems has solid solutions.
Fig. *17*.—Course of crystallization in a ternary system where one of the binary systems is a complete solid solution series.
Fig. *18*.—A ternary system containing a binary compound of two components stable at its melting point which forms a complete series of solid solutions with the third component.
Fig. *19*.—A ternary system containing a binary compound of two components unstable at its melting point which forms a series of solid solutions with the third component.
Fig. *20*.—Determination of the position of the three-phase boundary.

Part II. Specific Diagrams*

(1) One-Component System (SiO_2)

Fig. *21*.—Stability relations of silica minerals (McDowell).
Fig. *22*.—Stability relations of silica minerals (Fenner).
Fig. *23*.—Thermal expansion of quartz (Day, Sosman, and Hostetter).

(2) Two-Component Systems

(a) Both Components Simple Oxides

Fig. No.		Fig. No.	
24	CaO–MgO	*37*	CaO–SiO_2
25	NaF–AlF_3	*38*	FeO–SiO_2
26	CaF_2–Al_2O_3	*39*	MgO–SiO_2
27	CaO–Al_2O_3	*40*	MnO–SiO_2
28	CaO–B_2O_3	*41*	PbO–SiO_2
29	MgO–αAl_2O_3	*42*	SrO–SiO_2
30	ZnO–Al_2O_3	*43*	ZnO–SiO_2
31	Cr_2O_3–Al_2O_3	*44*	CaO–ZrO_2
32	CaO–Fe_2O_3	*45*	Al_2O_3–SiO_2
33	K_2SiO_3–SiO_2	*46*	Al_2O_3–TiO_2
34	Li_2O–SiO_2	*47*	ZrO_2–SiO_2
35	Na_2O–SiO_2	*48*	SiO_2–TiO_2
36	BaO–SiO_2	*49*	ZrO_2–ThO_2

* The major subdivisions with headings given below follow, in general, the arrangement used in the International Critical Tables. Within these subdivisions the systems and components are so arranged that an ascending valence order is followed from left to right and from top to bottom. Within a group of oxides having the same valence, an alphabetical arrangement is followed. Temperatures are given in degrees Centigrade and compositions in weight percentage unless otherwise stated on the individual diagrams.

(b) One Simple Oxide and a Binary Compound of Two Oxides

Fig. No.

50 CaF_2–$3NaF \cdot AlF_3$
51 Al_2O_3–$3NaF \cdot AlF_3$
52 Al_2O_3–$3NaF \cdot AlF_3$
53 $Na_2O \cdot SiO_2$–ZrO_2

(c) One Simple Oxide and a Ternary Compound

54 $K_2O \cdot Al_2O_3 \cdot 4SiO_2$–$SiO_2$
55 K_2SiO_3–Na_2SiO_3
56 $K_2Si_2O_5$–$Na_2Si_2O_5$

(d) Both Components Binary Compounds

57 $2Li_2O \cdot SiO_2$–$2CaO \cdot SiO_2$
58 $2CaO \cdot SiO_2$–$2FeO \cdot SiO_2$
59 $BaO \cdot SiO_2$–$CaO \cdot SiO_2$
60 $CaO \cdot SiO_2$–$SrO \cdot SiO_2$
61 $CaO \cdot SiO_2$–$CaO \cdot TiO_2$
62 $MnO \cdot SiO_2$–$MnO \cdot TiO_2$

(e) Two Ternary Compounds

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64 $K_2O \cdot Al_2O_3 \cdot 4SiO_2$–$CaO \cdot MgO \cdot 2SiO_2$
65 $Na_2O \cdot Al_2O_3 \cdot 2SiO_2$–$CaO \cdot MgO \cdot 2SiO_2$ (pseudo-binary)
66 $Na_2O \cdot Al_2O_3 \cdot 6SiO_2$–$CaO \cdot MgO \cdot 2SiO_2$
67 $Na_2O \cdot Al_2O_3 \cdot 2SiO_2$–$CaO \cdot Al_2O_3 \cdot 2SiO_2$
68 $Na_2O \cdot Al_2O_3 \cdot 6SiO_2$–$CaO \cdot Al_2O_3 \cdot 2SiO_2$
69 $CaO \cdot MgO \cdot 2SiO_2$–$CaO \cdot Al_2O_3 \cdot 2SiO_2$
70 $2CaO \cdot MgO \cdot 2SiO_2$–$2CaO \cdot Al_2O_3 \cdot SiO_2$

(3) Three-Component Systems

(a) All Components Simple Oxides

Fig. No.

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73 K_2O–CaO–Al_2O_3
74 Na_2O–CaO–Al_2O_3
75 K_2O–CaO–SiO_2
76 K_2O–CaO–SiO_2
77 Na_2O–CaO–SiO_2
78 Na_2O–CaO–SiO_2
79 Na_2O–Fe_2O_3–SiO_2
80 Na_2O–Fe_2O_3–SiO_2
81 Na_2O–Fe_2O_3–SiO_2
82 Na_2O–Fe_2O_3–SiO_2
83 Na_2O–Fe_2O_3–SiO_2
84 Na_2O–ZrO_2–SiO_2

Fig. No.

85 CaO–MgO–Al_2O_3
86 MgO–FeO–Fe_2O_3
87 MgO–FeO–Fe_2O_3
88 CaO–MgO–SiO_2
89 CaO–MgO–SiO_2
90 CaO–Al_2O_3–Fe_2O_3
91 CaO–Al_2O_3–Fe_2O_3
92 CaO–Al_2O_3–SiO_2
93 CaO–Fe_2O_3–SiO_2
94 MgO–Al_2O_3–SiO_2
95 ZnO–Al_2O_3–SiO_2
96 Fe_2O_3–Fe_3O_4–O_2
97 Fe_2O_3–Fe_3O_4–O_2

(b) At Least One Component a Binary or Higher Compound

98 CaF_2–Al_2O_3–$3NaF \cdot AlF_3$
99 $CaO \cdot Al_2O_3 \cdot 2SiO_2$–$2MgO \cdot SiO_2$–$SiO_2$
100 $Na_2O \cdot Al_2O_3 \cdot 6SiO_2$–$CaO \cdot MgO \cdot 2SiO_2$–$CaO \cdot Al_2O_3 \cdot 2SiO_2$
101 $90\%[3CaO \cdot Al_2O_3 \cdot 3SiO_2]$ $10\%[3Na_2O \cdot Al_2O_3 \cdot 3SiO_2]$–$2CaO \cdot MgO \cdot 2SiO_2$–$2CaO \cdot Al_2O_3 \cdot SiO_2$
102 $2CaO \cdot MgO \cdot 2SiO_2$–$2CaO \cdot Al_2O_3 \cdot SiO_2$–$3CaO \cdot Al_2O_3 \cdot 3SiO_2$

(4) Sections of Three-Component Systems

(a) The System K_2O–CaO–SiO_2

Fig. No.

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105 $K_2O \cdot 4SiO_2$–$CaO \cdot SiO_2$
106 $K_2O \cdot 2SiO_2$–$K_2O \cdot CaO \cdot SiO_2$

(b) The System Na_2O–CaO–SiO_2

107 $Na_2O \cdot SiO_2$–$CaO \cdot SiO_2$
108 $Na_2O \cdot 2CaO \cdot 3SiO_2$–$Na_2O \cdot 2SiO_2$

(c) The System Na_2O–Fe_2O_3–SiO_2

109 $Na_2O \cdot SiO_2$–Fe_2O_3
110 $Na_2O \cdot Fe_2O_3 \cdot 4SiO_2$–$Na_2O \cdot 2SiO_2$
111 $Na_2O \cdot Fe_2O_3 \cdot 4SiO_2$–$Na_2O \cdot SiO_2$
112 $Na_2O \cdot Fe_2O_3 \cdot 4SiO_2$–$Fe_2O_3$
113 $Na_2O \cdot Fe_2O_3 \cdot 4SiO_2$–$Na_2O \cdot 4SiO_2$
114 $5Na_2O \cdot Fe_2O_3 \cdot 8SiO_2$–$Fe_2O_3$
115 $5Na_2O \cdot Fe_2O_3 \cdot 8SiO_2$–$Na_2O \cdot 2SiO_2$

(d) The System CaO–MgO–SiO_2

116 $CaO \cdot MgO \cdot 2SiO_2$–$SiO_2$
117 $CaO \cdot MgO \cdot 2SiO_2$–$CaO \cdot SiO_2$
118 $CaO \cdot MgO \cdot 2SiO_2$–$2MgO \cdot SiO_2$
119 $2CaO \cdot MgO \cdot 2SiO_2$–$CaO \cdot SiO_2$
120 $2CaO \cdot MgO \cdot 2SiO_2$–$2CaO \cdot SiO_2$
121 $CaO \cdot MgO \cdot 2SiO_2$–$2CaO \cdot MgO \cdot 2SiO_2$
122 $CaO \cdot MgO \cdot 2SiO_2$–$2MgO \cdot SiO_2$–$SiO_2$

(e) The System CaO–Al_2O_3–Fe_2O_3

123 $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$–$CaO$
124 $CaO \cdot Al_2O_3$–$CaO \cdot Fe_2O_3$
125 $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$–$2CaO \cdot Fe_2O_3$
126 $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$–$5CaO \cdot 3Al_2O_3$

(f) The System CaO–Al_2O_3–SiO_2

127 $CaO \cdot Al_2O_3 \cdot 2SiO_2$–$Al_2O_3$
128 $CaO \cdot Al_2O_3 \cdot 2SiO_2$–$SiO_2$
129 $CaO \cdot Al_2O_3$–$CaO \cdot SiO_2$
130 $5CaO \cdot 3Al_2O_3$–$2CaO \cdot SiO_2$
131 $2CaO \cdot Al_2O_3 \cdot SiO_2$–$3CaO \cdot 5Al_2O_3$
132 $2CaO \cdot Al_2O_3 \cdot SiO_2$–$2CaO \cdot SiO_2$
133 $CaO \cdot Al_2O_3 \cdot 2SiO_2$–$CaO \cdot SiO_2$
134 $CaO \cdot Al_2O_3 \cdot 2SiO_2$–$2CaO \cdot Al_2O_3 \cdot SiO_2$

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138 Na_2SiO_3–Fe_2O_3–SiO_2
139 $90\%[3CaO \cdot Al_2O_3 \cdot 3SiO_2]$ $10\%[3Na_2O \cdot Al_2O_3 \cdot 3SiO_2]$–$2CaO \cdot MgO \cdot 2SiO_2$–$2CaO \cdot Al_2O_3 \cdot SiO_2$
140 $BaO \cdot 2SiO_2$–$2BaO \cdot 3SiO_2$
141 $CaO \cdot SiO_2$–$SrO \cdot SiO_2$
142 $2CaO \cdot SiO_2$–$2FeO \cdot SiO_2$
143 $MgO \cdot SiO_2$–$FeO \cdot SiO_2$
144 $MgO \cdot SiO_2$–$CaO \cdot MgO \cdot 2SiO_2$
145 $CaO \cdot FeO \cdot 2SiO_2$–$CaO \cdot MgO \cdot 2SiO_2$
146 $2CaO \cdot Fe_2O_3$–$4CaO \cdot Al_2O_3 \cdot Fe_2O_3$
147 $2CaO \cdot Al_2O_3 \cdot SiO_2$–$2CaO \cdot MgO \cdot 2SiO_2$
148 $2CaO \cdot Al_2O_3 \cdot SiO_2$–$2CaO \cdot MgO \cdot 2SiO_2$–$3CaO \cdot Al_2O_3 \cdot 3SiO_2$
149–156 Garnet groups

(6) Cone Deformation Diagrams

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157	$Al_2O_3 \cdot 2SiO_2$–CaO
158	$Al_2O_3 \cdot 2SiO_2$–MgO
159	$Al_2O_3 \cdot 2SiO_2$–FeO
160	$Al_2O_3 \cdot 2SiO_2$–potash feldspar
161	Microcline–steatite
162	Microcline–albite
163	Orthoclase–CaO
164	Orthoclase–MgO
165	Albite–CaO
166	Albite–MgO
167	Feldspar–flint–kaolin

(7) Melting Diagrams

168	MgO–NiO, CoO, Al_2O_3, Cr_2O_3, Fe_3O_4, Mn_3O_4, SiO_2, TiO_2, and ZrO_2
169	MgO–Cu_2O, CaO, BaO, SrO, BeO, and CeO_2
170	Al_2O_3–CaO, BaO, SrO, MgO, NiO, CoO, TiO_2, and SiO_2
171	Al_2O_3–BeO, Cu_2O, ZrO_2, ThO_2, CeO_2, La_2O_3, Mn_3O_4, Fe_3O_4, Ga_2O_3, and Cr_2O_3
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173	ZrO_2–BeO and MgO
174	ZrO_2–ZnO, NiO, CoO, Al_2O_3, Cr_2O_3, Fe_2O_3, Mn_3O_4, and (CeO_2, Ce_2O_3)
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176	ZrO_2–BeO–CeO_2
177	ZrO_2–ThO_2–CaO
178	ZrO_2–ThO_2–MgO

LIST OF DIAGRAMS IN SUPPLEMENT*

(1) Two-Component System

(a) Both Components Simple Oxides

Fig. No.		Fig. No.	
179	KF–NaF	193	Li_2O–B_2O_3
180	NaF–CaF_2	194	Na_2O–B_2O_3
181	LiF–MgF_2	195	CdO–B_2O_3
182	NaF–CdF_2	196	MnO–B_2O_3
183	NaF–PbF_2	197–198	PbO–B_2O_3
184	CaF_2–MgF_2	199	PbO–Bi_2O_3
185	PbF_2–PbO	200	Na_2O–TiO_2
186	FeO–MgO	201	MnO–SiO_2
187	KF–BaF_2	202	MgO–ZrO_2
188–189	KF–AlF_3	203	SiO_2–ZrO_2
190–191	LiF–AlF_3	204	PbO–As_2O_5
192	FeO–Al_2O_3	205	PbO–V_2O_5

(b) One Simple Oxide and a Binary Compound of Two Oxides

206	NaF–$Na_2O \cdot SiO_2$	214	$Na_2O \cdot MoO_3$–MoO_3
207	CaF_2–$CaO \cdot SiO_2$	215	$Na_2O \cdot WO_3$–WO_3
208	$3K_2O \cdot As_2O_5$–As_2O_5	216	$CaO \cdot SiO_2$–TiO_2
209	$3Na_2O \cdot As_2O_5$–As_2O_5	217	$CaO \cdot TiO_2$–SiO_2
210	PbF_2–$3PbO \cdot As_2O_5$	218	PbO–$PbO \cdot CrO_3$
211	PbF_2–$3PbO \cdot V_2O_5$	219	PbO–$PbO \cdot MoO_3$
212	$K_2O \cdot MoO_3$–MoO_3	220	PbO–$PbO \cdot WO_3$
213	$K_2O \cdot WO_3$–WO_3		

(c) Both Components Binary Compounds

221	$K_2O \cdot B_2O_3$–$Na_2O \cdot B_2O_3$
222	$CaO \cdot SiO_2$–$MnO \cdot SiO_2$
223	$2FeO \cdot SiO_2$–$2MgO \cdot SiO_2$
224	$2K_2O \cdot As_2O_5$–$2NaO \cdot As_2O_5$
225	$K_2O \cdot CrO_3$–$Na_2O \cdot CrO_3$
226	$K_2O \cdot MoO_3$–$Na_2O \cdot MoO_3$
227	$K_2O \cdot WO_3$–$Na_2O \cdot WO_3$
228	$Na_2O \cdot MoO_3$–$Na_2O \cdot WO_3$
229	$PbO \cdot CrO_3$–$PbO \cdot SO_3$
230	$PbO \cdot MoO_3$–$PbO \cdot WO_3$
231	$PbO \cdot MoO_3$–$Bi_2O_3 \cdot 3MoO_3$
232	$PbO \cdot WO_3$–$Bi_2O_3 \cdot 3WO_3$

(d) One Binary and One Ternary Compound

233	$Na_2O \cdot Al_2O_3 \cdot 2SiO_2$–$Na_2O \cdot 2SiO_2$
234	$Na_2O \cdot Al_2O_3 \cdot 6SiO_2$–$2FeO \cdot SiO_2$
235	$4CaO \cdot Al_2O_3 \cdot Fe_2O_3$–$2CaO \cdot SiO_2$
236	$CaO \cdot Al_2O_3 \cdot 2SiO_2$–$CaO \cdot TiO_2$
237	$CaO \cdot MgO \cdot 2SiO_2$–$CaO \cdot TiO_2$
238	$CaO \cdot SiO_2 \cdot TiO_2$–$MnO \cdot TiO_2$

(2) Three-Component Systems

(a) All Components Simple Oxides

Fig. No.	
239–240	K_2O–CaO–Al_2O_3
241–243	K_2O–PbO–SiO_2
244	Fe_2O_3–Fe_3O_4–O_2
245–247	CaO–Al_2O_3–Fe_2O_3
248–266	CaO–FeO–SiO_2
267–278	FeO–MgO–SiO_2
279–280	FeO–MnO–SiO_2
281–287	CaO–B_2O_3–SiO_2
288	FeO–Fe_2O_3–SiO_2

(b) At Least One Component a Binary or Higher Compound

289	$Na_2O \cdot Al_2O_3 \cdot 2SiO_2$–FeO–$SiO_2$
290–292	$K_2O \cdot Al_2O_3 \cdot 2SiO_2$–$Na_2O \cdot Al_2O_3 \cdot 2SiO_2$–$SiO_2$
293–294	$K_2O \cdot Al_2O_3 \cdot 6SiO_2$–$Fe_2O_3$–$SiO_2$
295	$Na_2O \cdot Al_2O_3 \cdot 2SiO_2$–$Na_2O \cdot SiO_2$–$Na_2O \cdot 2SiO_2$
296	$K_2O \cdot Al_2O_3 \cdot 4SiO_2$–$CaO \cdot MgO \cdot 2SiO_2$–$SiO_2$
297	$K_2O \cdot Al_2O_3 \cdot 4SiO_2$–$CaO \cdot Al_2O_3 \cdot 2SiO_2$–$SiO_2$
298	$CaO \cdot Al_2O_3 \cdot 2SiO_2$–$CaO \cdot SiO_2$–$CaO \cdot SiO_2 \cdot TiO_2$

(3) Four-Component Systems

299–306	CaO–$5CaO \cdot 3Al_2O_3$–$4CaO \cdot Al_2O_3 \cdot Fe_2O_3$–$2CaO \cdot SiO_2$
307–309	CaO–MgO–$5CaO \cdot 3Al_2O_3$–$2CaO \cdot SiO_2$
310	FeO–Fe_2O_3–Al_2O_3–SiO_2

(4) Relation of Optical Properties to Chemical Composition

311	FeO–MgO
312	$FeO \cdot SiO_2$–$MgO \cdot SiO_2$
313	$2FeO \cdot SiO_2$–$2MgO \cdot SiO_2$
314	$K_2O \cdot Al_2O_3 \cdot 6SiO_2$–$Fe_2O_3$–$SiO_2$
315	FeO–MgO–SiO_2
316–317	CaO–FeO–SiO_2

(5) Melting Diagrams

318	SiO_2 with K_2O, Li_2O, Na_2O, or Rb_2O
319	SiO_2 with K_2O, Li_2O, Na_2O, Rb_2O, Cs_2O, BaO, CaO, MgO, or SrO
320	BeO with Al_2O_3, CaO, CeO_2, CoO, Cr_2O_3, Cu_2O, Fe_3O_4, La_2O_3, MgO, Mn_3O_4, NiO, ThO_2, or ZrO_2
321	BeO–TiO_2
322	CaO with BeO, Mn_3O_4, or ZrO_2
323	CaO with Al_2O_3, Cu_2O, SiO_2, or TiO_2
324	CaO with BeO, CoO, Cu_2O, MgO, Mn_3O_4, NiO, or ThO_2
325	CaO with Al_2O_3, Cr_2O_3, Fe_2O_3, SiO_2, TiO_2, or ZrO_2
326	CaO with CoO, NiO, MgO, or ThO_2
327	MgO–La_2O_3
328	Al_2O_3–Mn_3O_4
329	CeO_2 with Al_2O_3, BeO, CaO, Cr_2O_3, Fe_3O_4, MgO, Mn_3O_4, or ZrO_2
330	La_2O_3–ZrO_2
331	ThO_2–TiO_2
332	ZrO_2 and NiO, CoO, and Mn_3O_4

* Italic figures throughout indicate reference to 1933 diagrams; Roman figures indicate diagrams in Supplement.

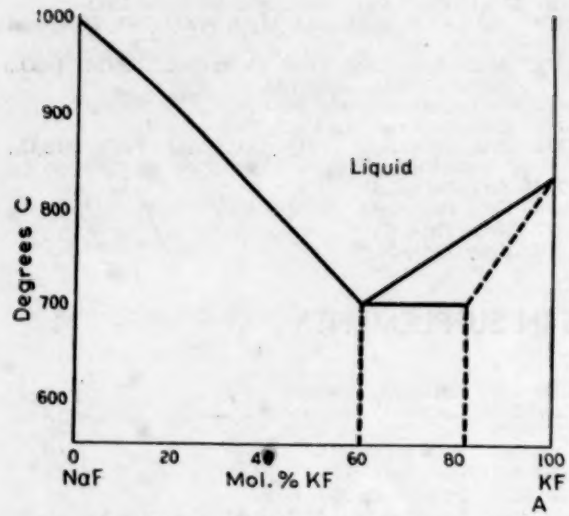

FIG. 179.—System NaF–KF. N. S. KURNAKOV AND S. F. ZHEMCHUZHNUI, *Z. anorg. Chem.*, **52**, 186 (1907); *Int. Critical Tables*, **4**, 67 (1928).

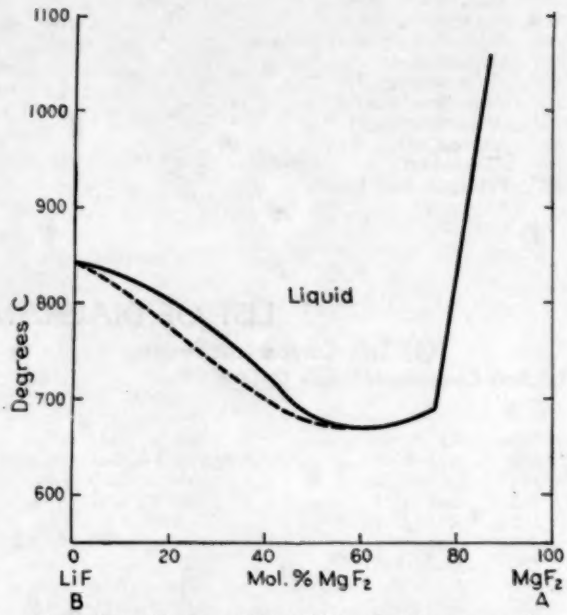

FIG. 181.—System MgF_2–LiF. G. TACCHINI, *Gaz. chim. ital.*, **54**, 777 (1924); *Int. Critical Tables*, **4**, 62 (1928); *Ceram. Abs.*, **4** [2] 47 (1925).

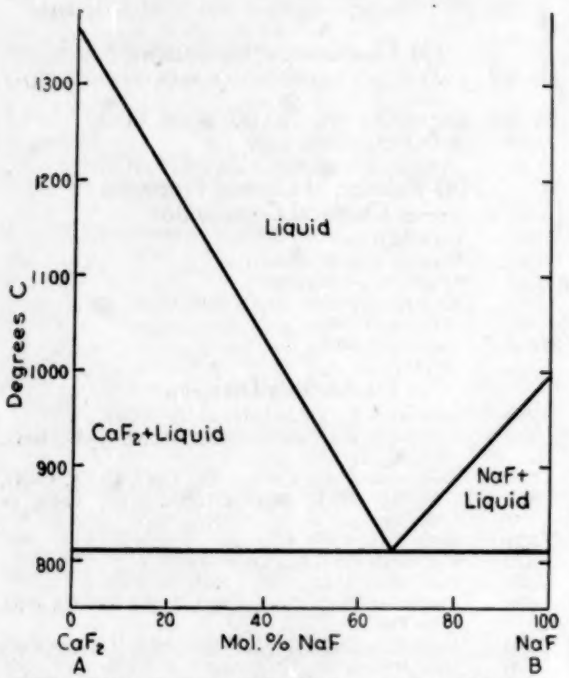

FIG. 180.—System CaF_2–NaF. P. P. FEDOTIEV AND W. P. ILYINSKIĬ (FEDOTIEFF AND ILJINSKY). *Z. anorg. allgem. Chem.*, **129**, 93–107 (1923); *Int. Critical Tables*, **4**, 63 (1928); *Ceram. Abs.*, **3** [3] 89 (1924).

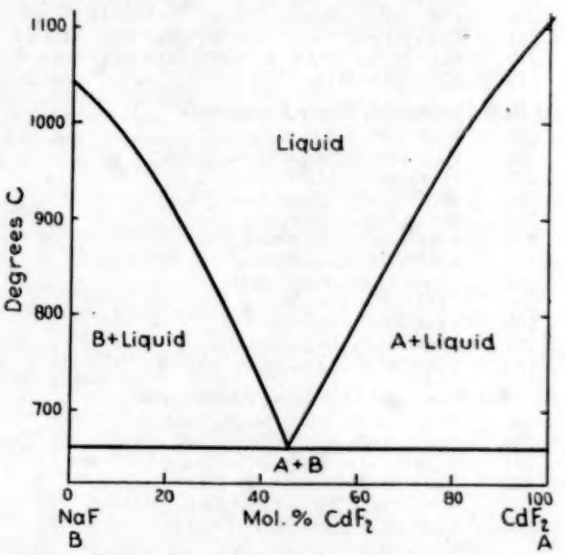

FIG. 182.—System CdF_2–NaF. N. A. PUSHIN AND A. V. BASKOW, *Z. anorg. Chem.*, **81**, 347 (1913); *Int. Critical Tables*, **4**, 55 (1928).

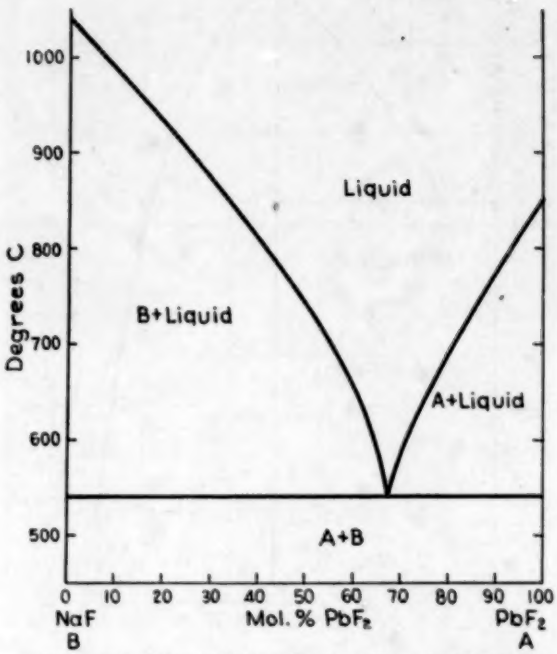

FIG. 183.—System PbF_2–NaF. N. A. PUSHIN AND A. V. BASKOW, *Z. anorg. Chem.*, **81**, 347 (1913); *Int. Critical Tables*, **4**, 50 (1928).

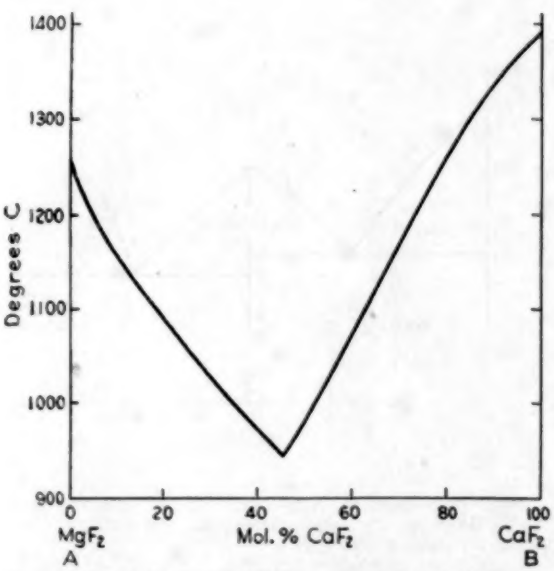

FIG. 184.—System MgF_2–CaF_2. E. BECK, *Metallurgie*, **5**, 504 (1908); *Int. Critical Tables*, **4**, 62 (1928).

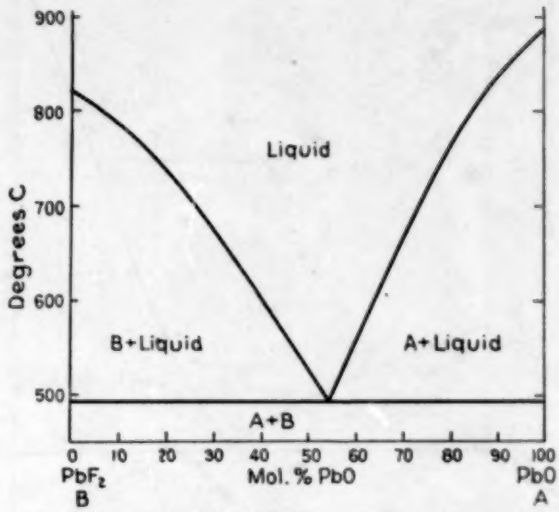

FIG. 185.—System PbO–PbF_2. C. SANDONNINI, *Atti accad. Lincei*, **23** [I] 959 (1914); *Int. Critical Tables*, **4**, 49 (1928).

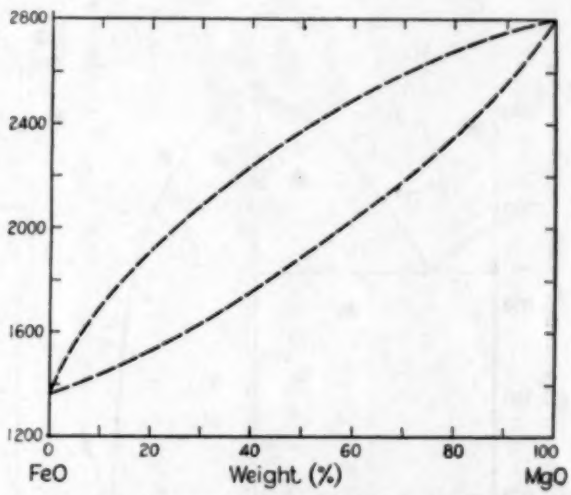

FIG. 186.—System FeO–MgO. N. L. BOWEN AND J. F. SCHAIRER, *Amer. Jour. Sci.*, **29**, 151–217 (1935); *Ceram. Abs.*, **15** [9] 288 (1936). This system has not been studied in detail, but the equilibrium diagram is believed to be as shown above if the incongruent melting of FeO is neglected. The diagram indicates a complete series of solid solutions composed of FeO and MgO. These solutions are designated as magnesio-wüstites. Refer to Fig. 311 (p. 149) for optical properties of these solutions.

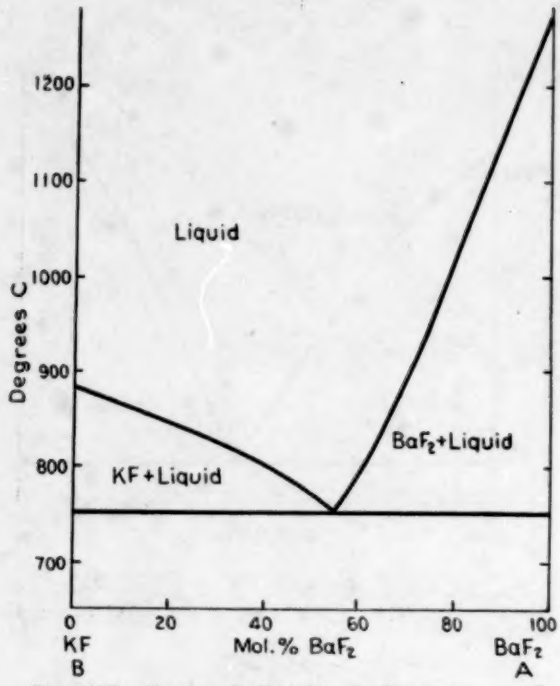

FIG. 187.—System BaF_2–KF. J. PONOMAREV. *Z. anorg. Chem.*, **89**, 382 (1914); *Int. Critical Tables*, **4**, 65 (1928).

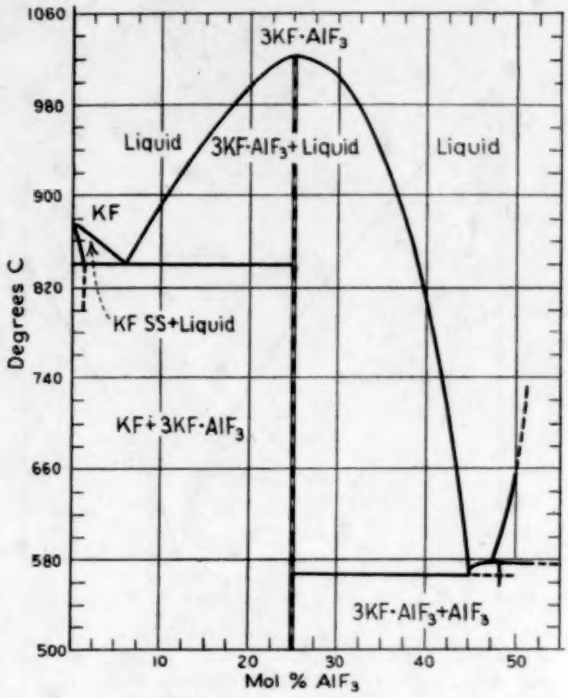

FIG. 189.—Systems KF–$3KF{\cdot}AlF_3$ and $3KF{\cdot}AlF_3$–AlF_3. P. P. FEDOTIEFF AND K. TIMOFEEFF, *Z. anorg. allgem. Chem.*, **206**, 266 (1932); *Ceram. Abs.*, **13** [8] 223 (1934).

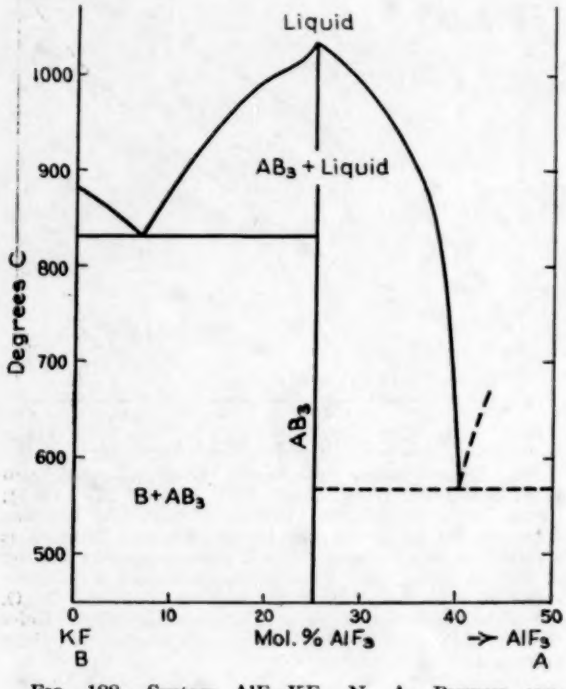

FIG. 188.—System AlF_3–KF. N. A. PUSHIN AND A. V. BASKOW, *Z. anorg. Chem.*, **81**, 347 (1913); *Int. Critical Tables*, **4**, 61 (1928).

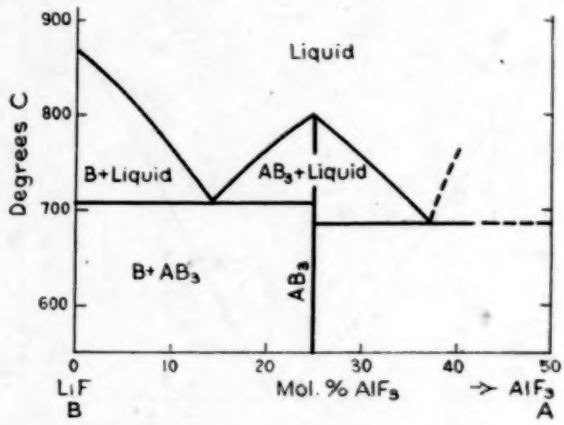

FIG. 190.—System AlF_3–LiF. N. A. PUSHIN AND A. V. BASKOW, *Z. anorg. Chem.*, **81**, 347 (1913); *Int. Critical Tables*, **4**, 61 (1928).

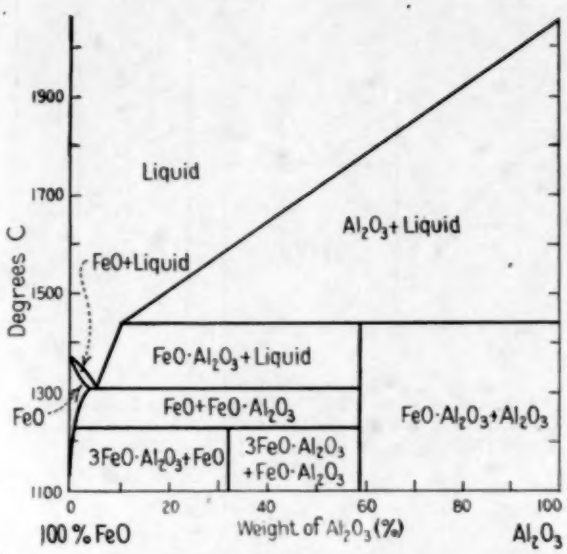

FIG. 192.—System FeO–Al_2O_3. A. B. McINTOSH, J. R. RAIT, AND R. HAY, *Jour. Roy. Tech. Coll.*, **4**, 72 (1937).

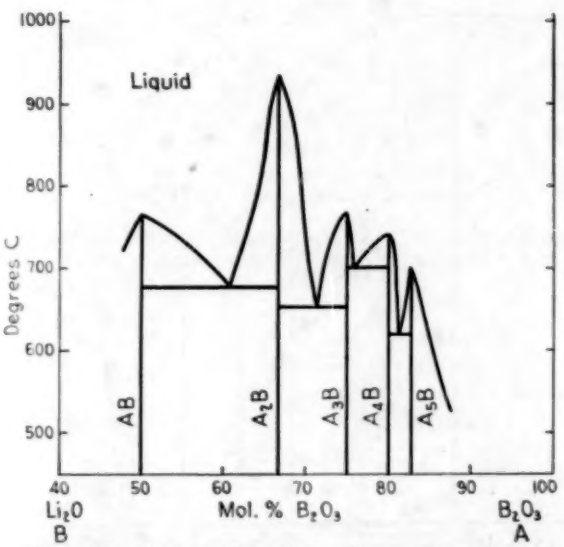

FIG. 193.—System B_2O_3–Li_2O. Drawn from data of C. MAZZETTI AND F. DE CARLI. *Gaz. chim. ital.*, **56** [II] 19 (1926); *Int. Critical Tables*, **4**, 61 (1928); *Ceram. Abs.*, **5** [7] 228 (1926).

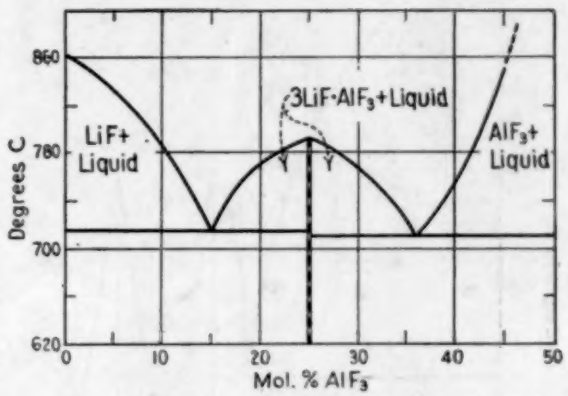

FIG. 191.—Systems LiF–3LiF·AlF_3 and 3LiF·AlF_3–AlF_3. P. P. FEDOTIEFF AND K. TIMOFEEFF, *Z. anorg. allgem. Chem.*, **206**, 266 (1932).

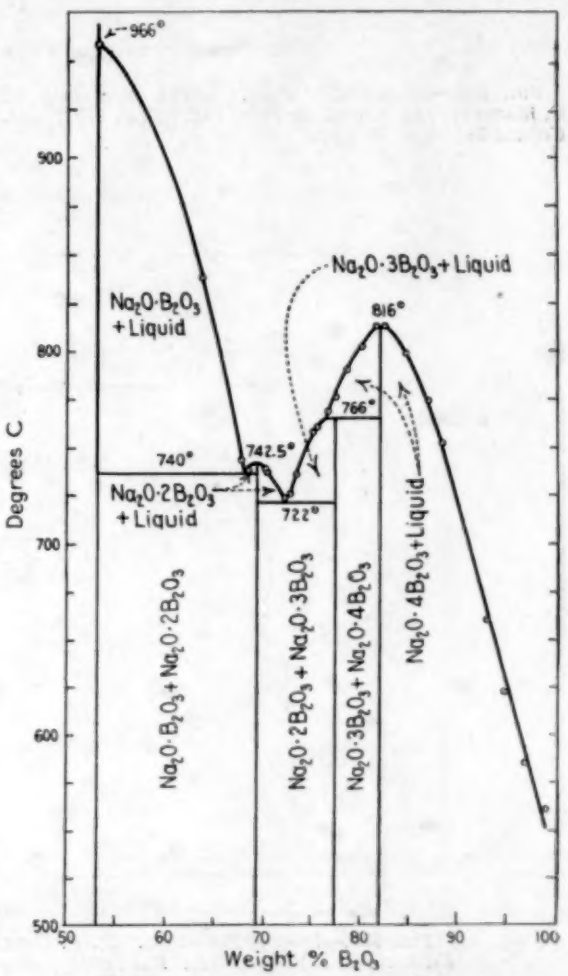

FIG. 194.—System $Na_2O·B_2O_3$–B_2O_3 (modified form). G. W. MOREY AND H. E. MERWIN, *Jour. Amer. Chem. Soc.*, **58**, 2248–54 (1936); *Ceram. Abs.*, **16** [11] 355 (1937).

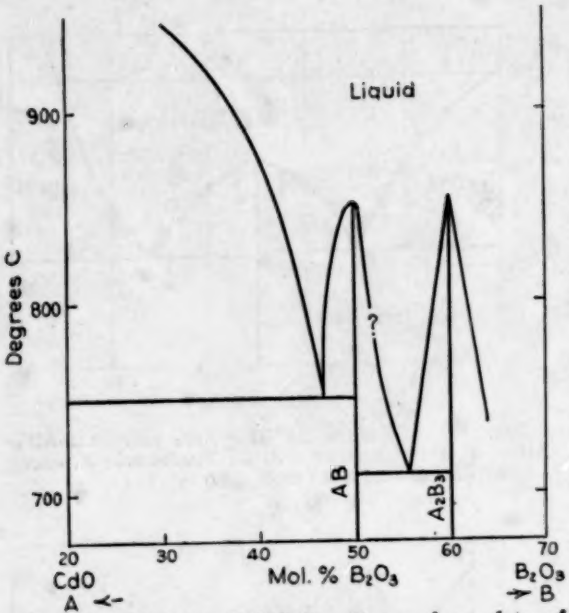

FIG. 195.—System CdO–B_2O_3. Drawn from data of C. MAZZETTI AND F. DE CARLI (see Fig. 193, p. 119); *Int. Critical Tables*, **4**, 55 (1928).

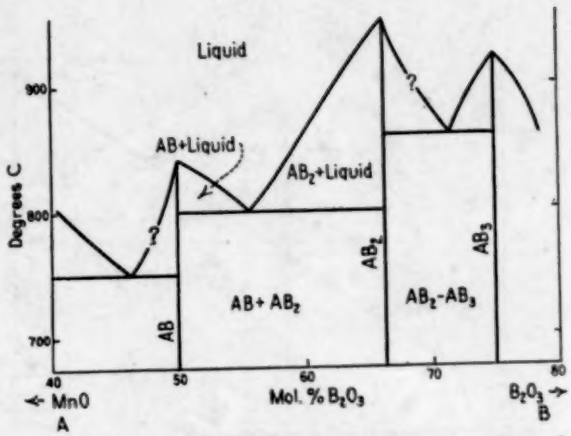

FIG. 196.—System MnO–B_2O_3. Drawn from data of C. MAZZETTI AND F. DE CARLI, *Gazz. chim. ital.*, **56** [II] 19–29 (1926); *Ceram. Abs.*, **5** [7] 228 (1926).

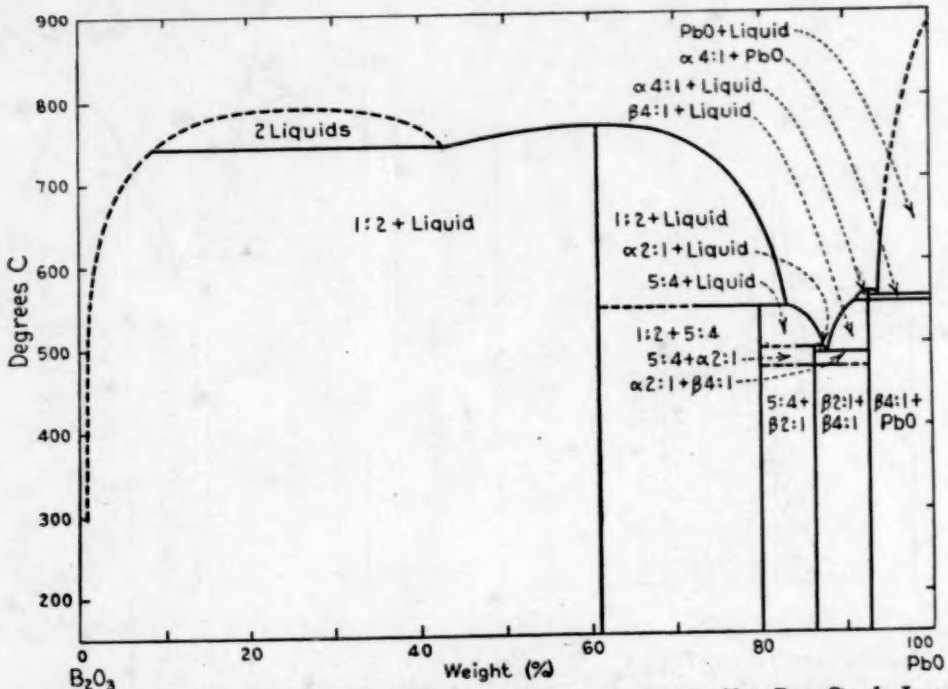

FIG. 197.—System PbO–B_2O_3. R. F. GELLER AND E. N. BUNTING, *Nat. Bur. Stand. Jour. Research*, **18** [5] 585 (1937); R. P. 995; *Ceram. Abs.*, **16** [8] 260 (1937). The PbO-rich portion of this system is given in detail in Fig. 198, p. 121.

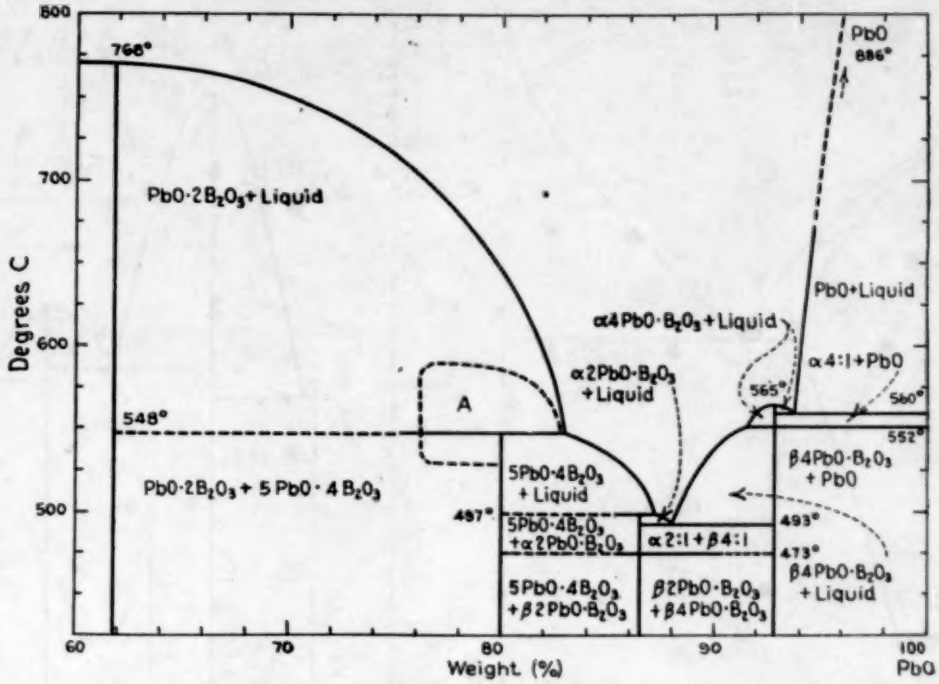

FIG. 198.—$PbO \cdot 2B_2O_3$–PbO portion of the PbO–B_2O_3 system. R. F. GELLER AND E. N. BUNTING (see Fig. 197).

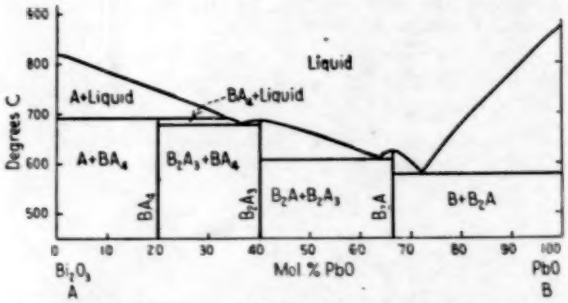

FIG. 199.—System Bi_2O_3–PbO. L. BELLADEN, *Gazz. chim. ital.*, **52** [1] 161 (1922); *Int. Critical Tables*, **4**, 47 (1928).

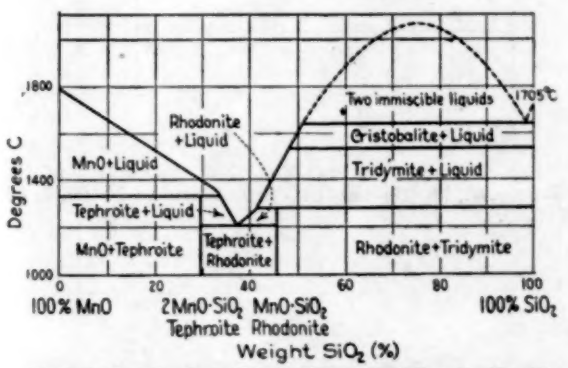

FIG. 201.—System MnO–SiO_2. J. WHITE, D. D. HOWAT, AND R. HAY, *Jour. Roy. Tech. Coll.* [Glasgow], **3**, 239 (1933–36).

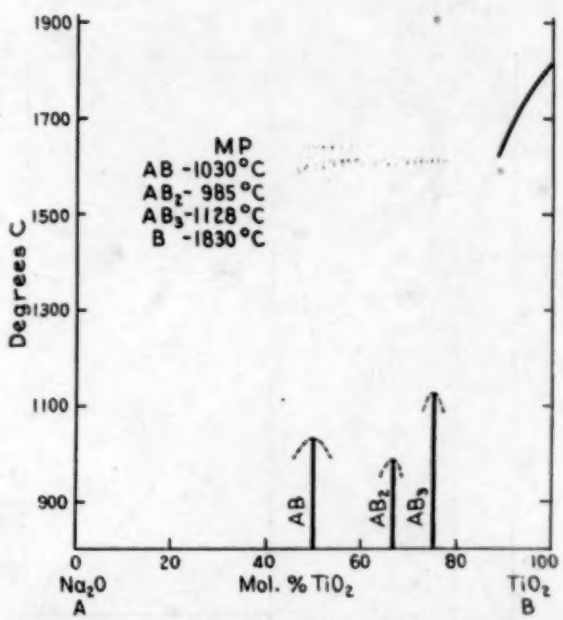

FIG. 200.—System Na_2O–TiO_2. E. W. WASHBURN AND E. N. BUNTING, *Bur. Stand. Jour. Research*, **12** [2] 239 (1934); R. P. 648; *Ceram. Abs.*, **13** [5] 131 (1934). For melting point of TiO_2, see E. N. BUNTING, *Bur. Stand. Jour. Research*, **11**, 719–25 (1933); R. P. 619; *Ceram. Abs.*, **13** [3] 71 (1934).

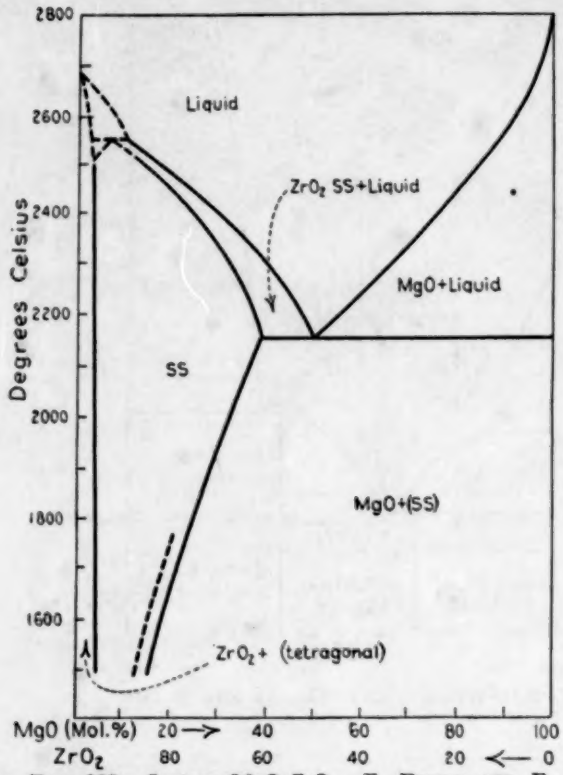

FIG. 202.—System MgO–ZrO_2. F. EBERT AND E. COHN, *Z. anorg. allgem. Chem.*, **213**, 321 (1933); *Ceram. Abs.*, **13** [7] 181 (1934).

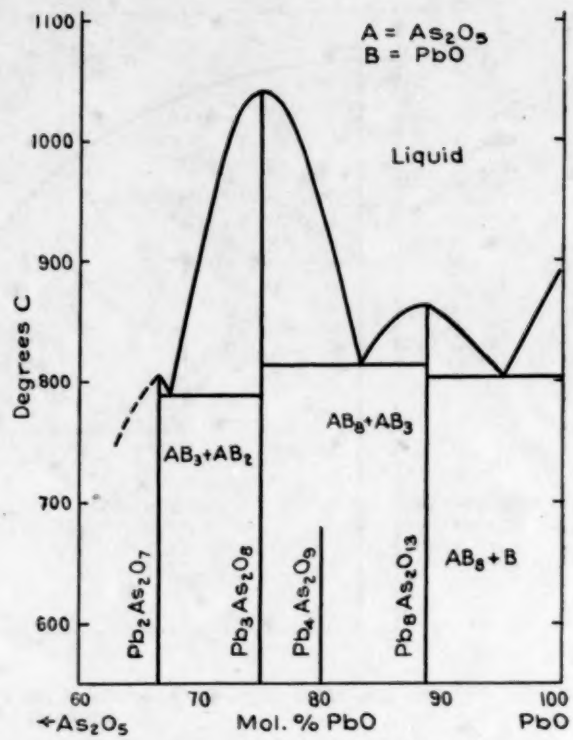

FIG. 204.—System As_2O_5–PbO. Modified from M. AMADORI, *Atti ist. Veneto sci.*, **76** [II] 419 (1917); *Int. Critical Tables*, **4**, 46 (1928).

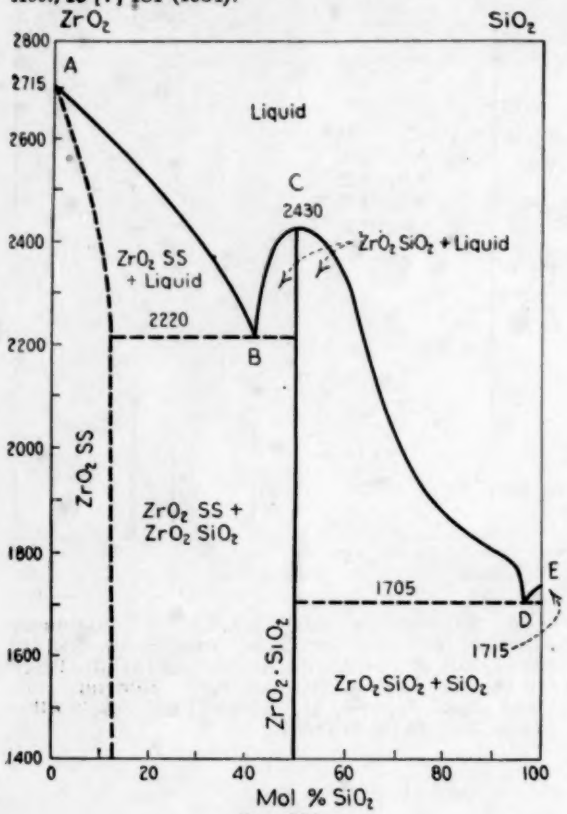

FIG. 203.

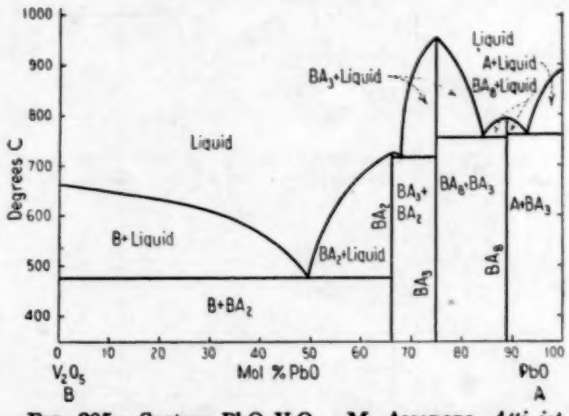

FIG. 205.—System PbO–V_2O_5. M. AMADORI, *Atti ist. Veneto sci.*, **76** [II] 419 (1917); *Int. Critical Tables*, **4**, 50 (1928).

FIG. 203.—System SiO_2–ZrO_2. N. ZIRNOWA, *Z. anorg. allgem. Chem.*, **218**, 198 (1934); *Ceram. Abs.*, **13** [9] 243 (1934).

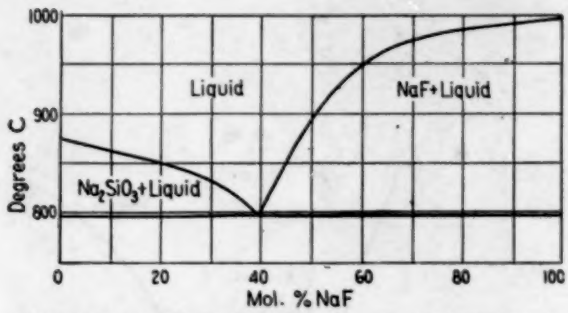

FIG. 206.—System Na_2SiO_3–NaF. H. S. BOOTH, B. A. STARRS, AND M. J. BAHNSEN, *Jour. Phys. Chem.*, **37**, 1106 (1933); *Ceram. Abs.*, **13** [7] 174 (1934).

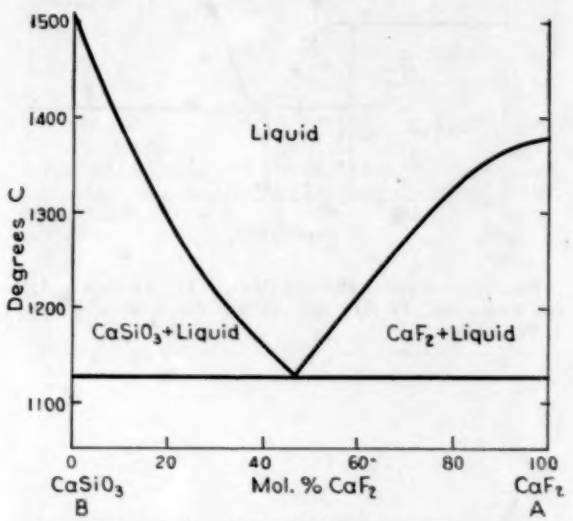

FIG. 207.—System CaF_2–$CaSiO_3$. B. KARANDYEEV, *Z. anorg. Chem.*, **68**, 188 (1910); *Int. Critical Tables*, **4**, 63 (1928).

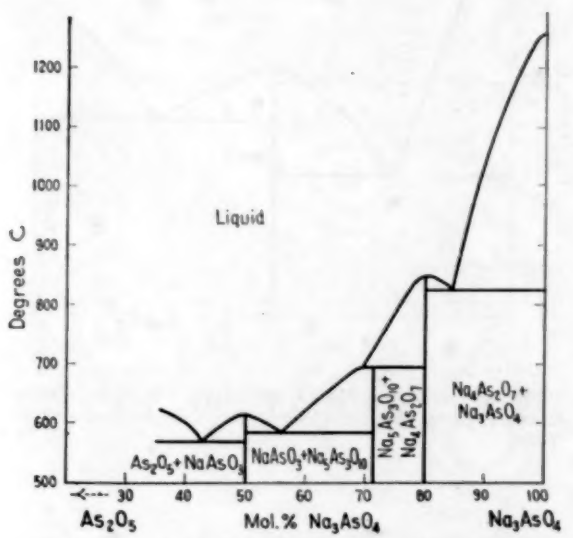

FIG. 209.—System As_2O_5–Na_3AsO_4. M. AMADORI, *Atti ist. Veneto sci.*, **73** [II] 1679 (1914); *Int. Critical Tables*, **4**, 46 (1928).

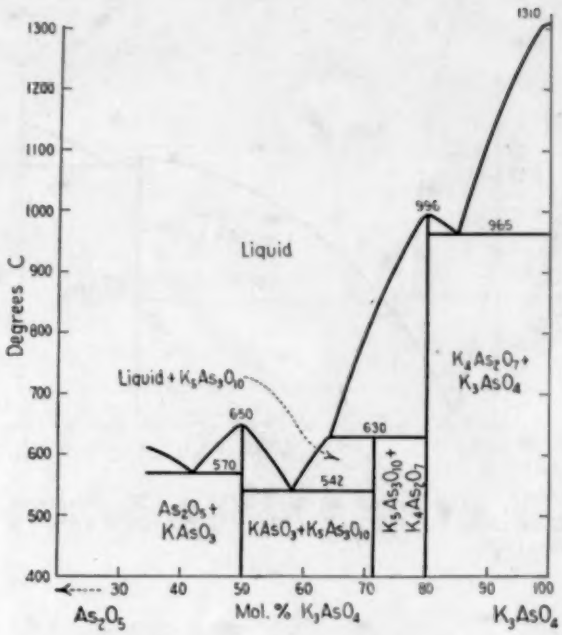

FIG. 208.—System As_2O_5–K_3AsO_4. M. AMADORI, *Atti ist. Veneto. sci.*, **73** [II] 1679 (1914); *Int. Critical Tables*, **4**, 46 (1928).

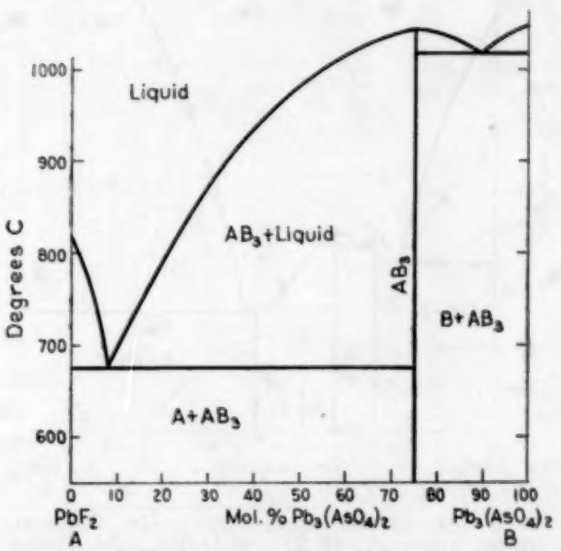

FIG. 210.—System PbF_2–$Pb_3(AsO_4)_2$. M. AMADORI, *Atti accad. Lincei*, **24** [II] 200 (1915). Drawn from data given in *Int. Critical Tables*, **4**, 50 (1928).

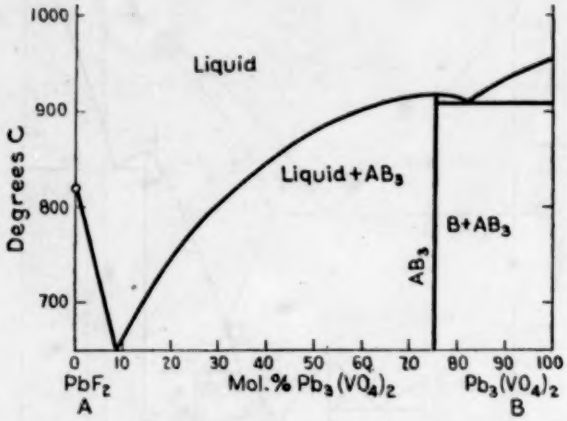

FIG. 211.—System PbF_2–$Pb_3(VO_4)_2$. M. AMADORI, *Gazz. chim. ital.*, **49** [I] 38 (1919); *Int. Critical Tables*, **4**, 50 (1928).

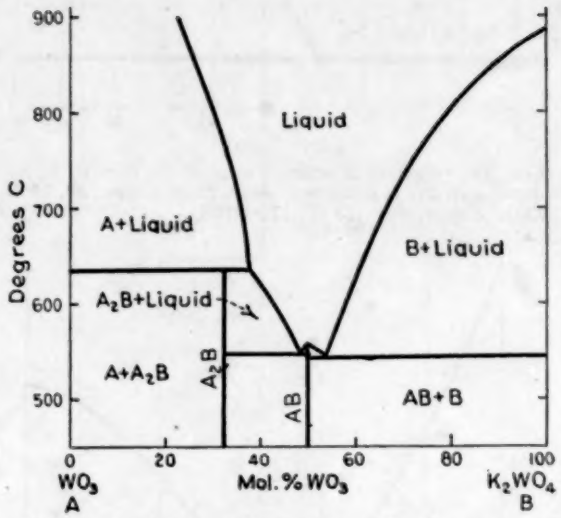

FIG. 213.—System WO_3–K_2WO_4. M. AMADORI, *Atti ist. Veneto sci.*, **72** [II] 893 (1913); *Int. Critical Tables*, **4**, 61 (1928).

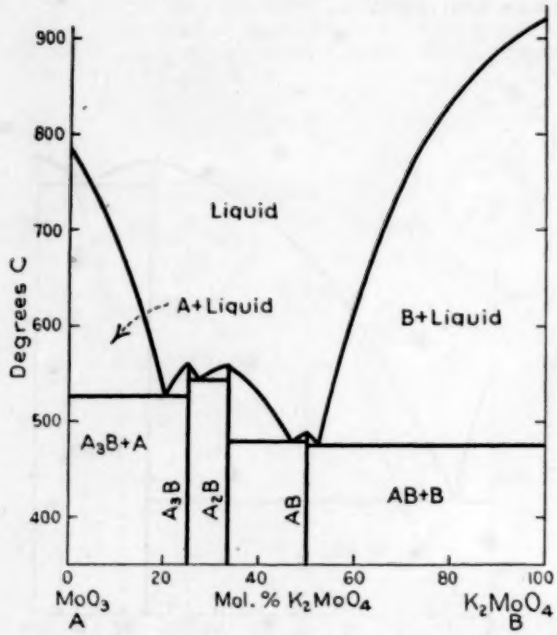

FIG. 212.—System MoO_3–K_2MoO_4. M. AMADORI, *Atti ist. Veneto sci.*, **72** [II] 893 (1913); *Int. Critical Tables*, **4**, 61 (1928).

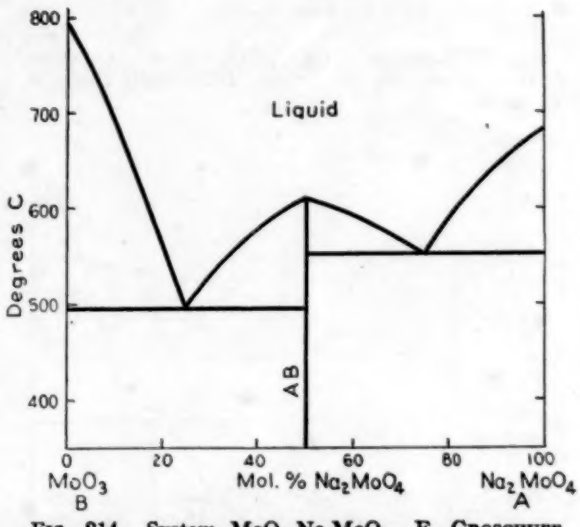

FIG. 214.—System MoO_3–Na_2MoO_4. E. GROSCHUFF, *Z. anorg. Chem.*, **58**, 113 (1908); *Int. Critical Tables*, **4**, 61 (1928).

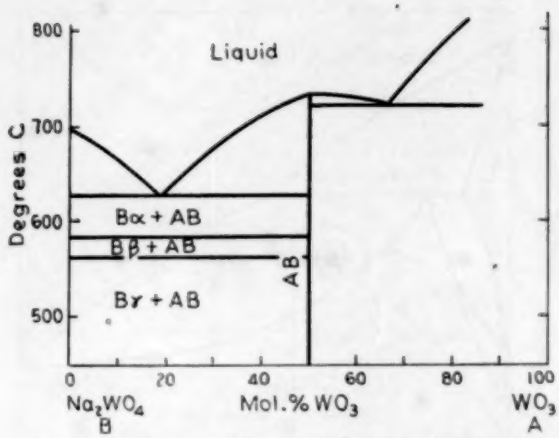

FIG. 215.—System WO_3–Na_2WO_4. N. PARRAVANO, *Gazz. chim. ital.*, **39** [II] 55 (1909); *Int. Critical Tables*, **4**, 61 (1928).

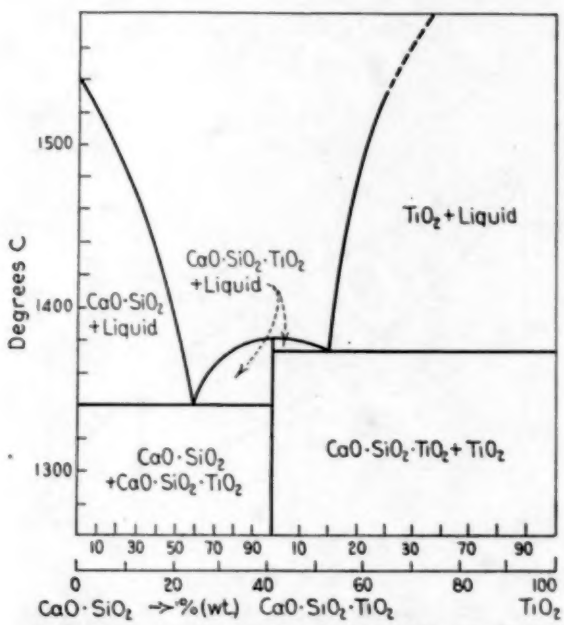

FIG. 216.—System $CaO·SiO_2$–TiO_2. KEIZO IWASÉ AND M. FUKUSIMA, *Science Repts., Tôhoku Imp. Univ., Series 1, Honda Anniv. Vol.*, p. 456 (1936); *Ceram. Abs.*, **16** [5] 162 (1937).

FIG. 219.—System PbO–$PbMoO_4$. F. M. JAEGER AND H. C. GERMS, *Z. anorg. allgem. Chem.*, **119**, 145 (1921); *Int. Critical Tables*, **4**, 50 (1928).

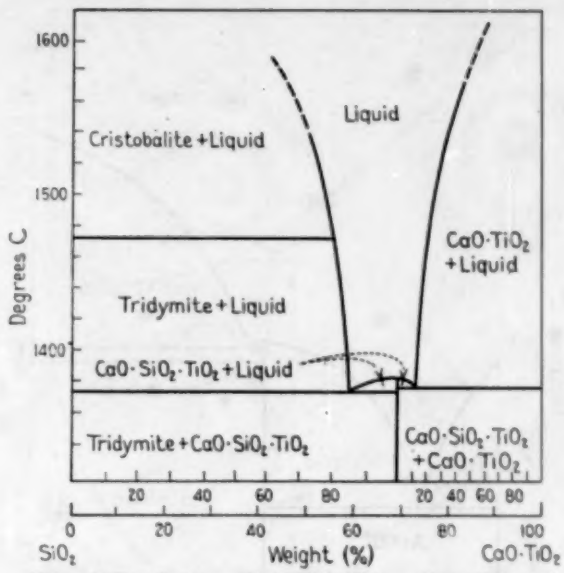

FIG. 217.—System $CaO·TiO_2$–SiO_2. KEIZO IWASÉ AND M. FUKUSIMA, *Science Repts., Tôhoku Imp. Univ., Series 1, Honda Anniv. Vol.*, p. 455 (1936).

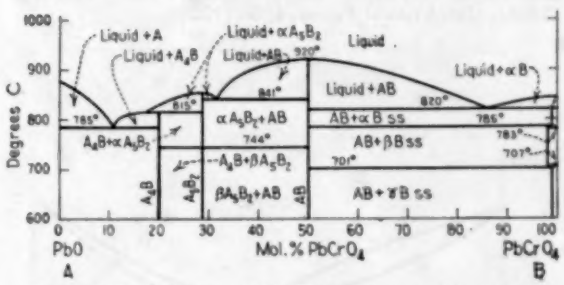

FIG. 218.—System PbO–$PbCrO_4$. F. M. JAEGER AND H. C. GERMS, *Z. anorg. allgem. Chem.*, **119**, 145 (1921); *Int. Critical Tables*, **4**, 50 (1928).

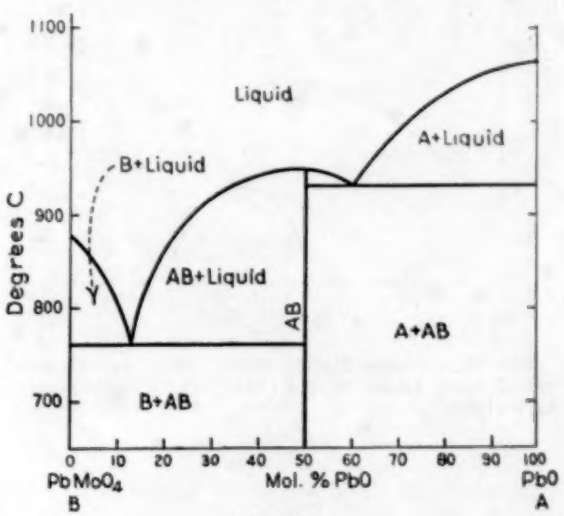

FIG. 219.

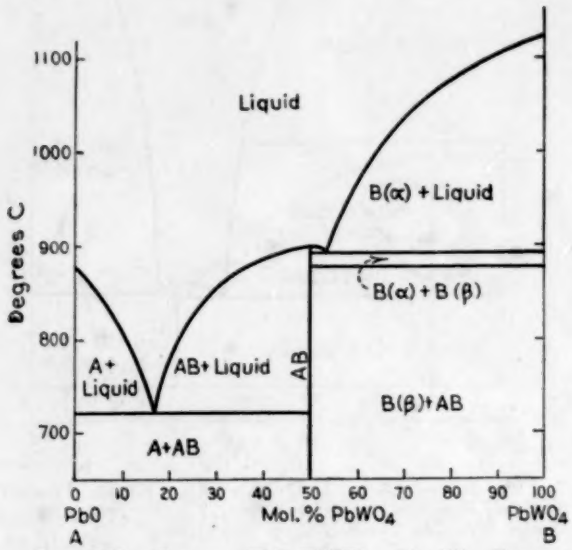

FIG. 220.—System PbO–$PbWO_4$. F. M. JAEGER AND H. C. GERMS, *Z. anorg. allgem. Chem.*, **119**, 145 (1921); *Int. Critical Tables*, **4**, 50 (1928).

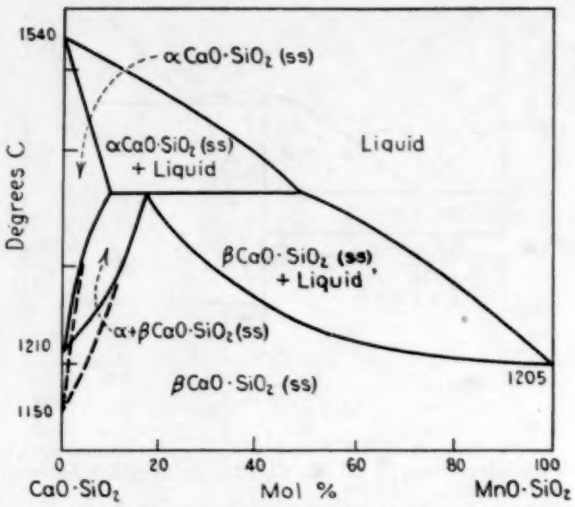

FIG. 222.—System $CaO \cdot SiO_2$–$MnO \cdot SiO_2$. E. VOOS, *Z. anorg. allgem. Chem.*, **222**, 213 (1935); *Ceram. Abs.*, **14** [8] 201 (1935).

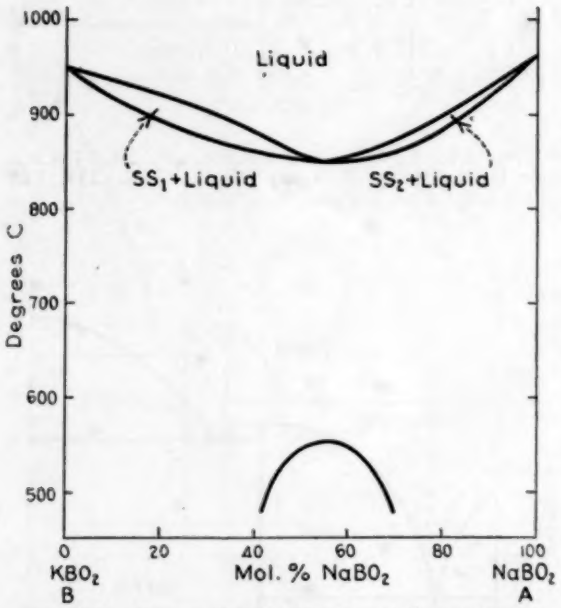

FIG. 221.—System $NaBO_2$–KBO_2. H. S. VAN KLOOSTER, *Z. anorg. Chem.*, **69**, 122 (1910); *Int. Critical Tables*, **4**, 70 (1928).

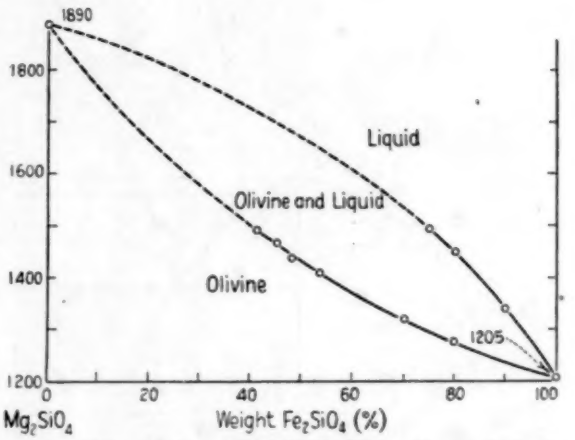

FIG. 223.—System Mg_2SiO_4–Fe_2SiO_4. N. L. BOWEN AND J. F. SCHAIRER, *Amer. Jour. Sci.*, **29**, 151–217 (1935); *Ceram. Abs.*, **15** [9] 288 (1936).

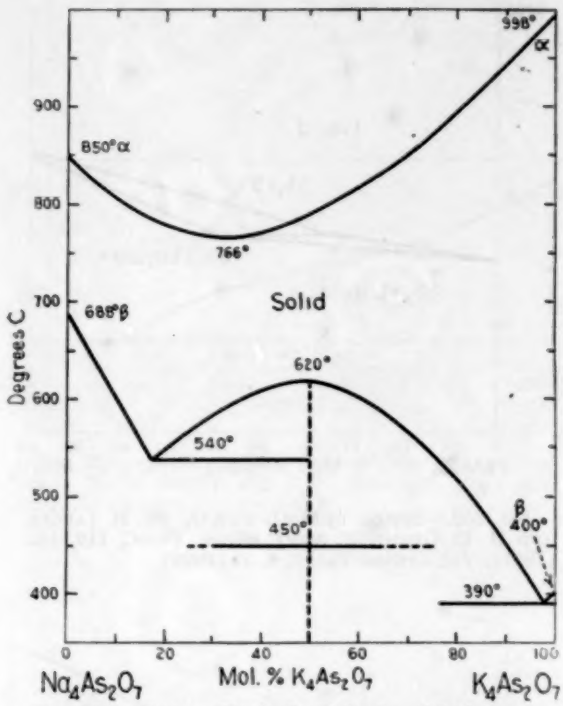

FIG. 224.—System $Na_4As_2O_7$–$K_4As_2O_7$. M. AMADORI, *Atti ist. Veneto sci.*, **76** [II] 419 (1917); *Int. Critical Tables*, **4**, 69 (1928).

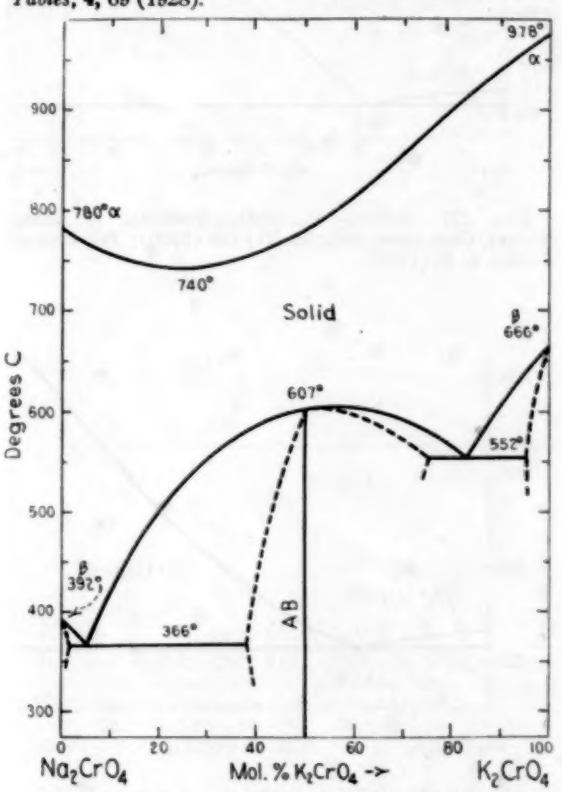

FIG. 225.—System Na_2CrO_4–K_2CrO_4. M. AMADORI, *Atti ist. Veneto sci.*, **72** [II] 903 (1913); *Int. Critical Tables*, **4**, 69 (1928).

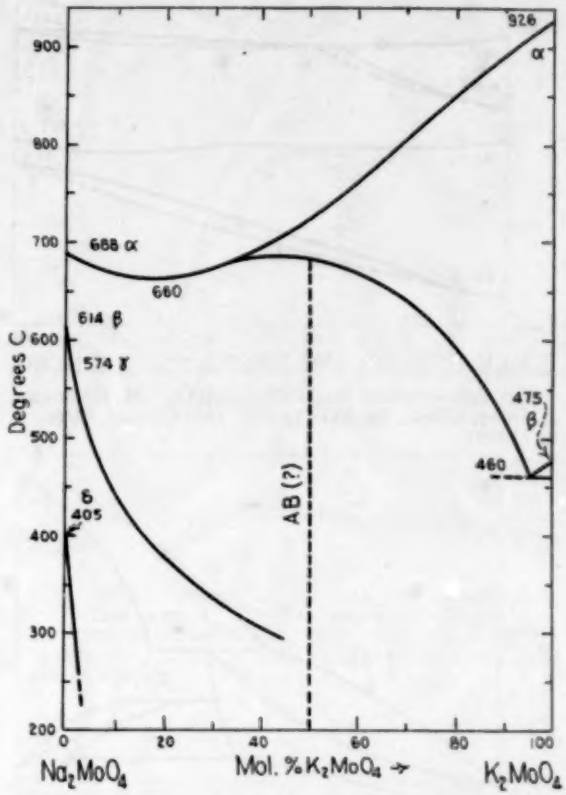

FIG. 226.—System Na_2MoO_4–K_2MoO_4. M. AMADORI, *Atti ist. Veneto sci.*, **72** [II] 903 (1913); *Int. Critical Tables*, **4**, 69 (1928).

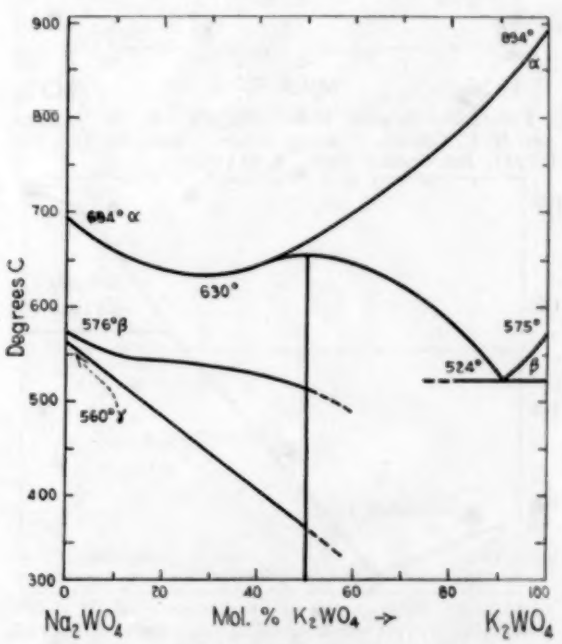

FIG. 227.—System Na_2WO_4–K_2WO_4. M. AMADORI, *Atti ist. Veneto sci.*, **72** [II] 903 (1913); *Int. Critical Tables*, **4**, 69 (1928).

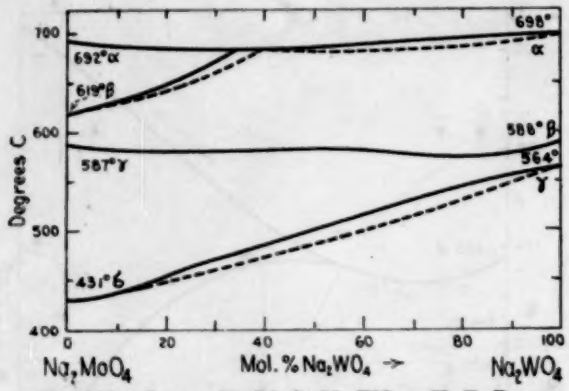

FIG. 228.—System Na_2MoO_4–Na_2WO_4. H. E. BOEKE, *Z. anorg. Chem.*, **50**, 355 (1906); *Int. Critical Tables*, **4**, 69 (1928).

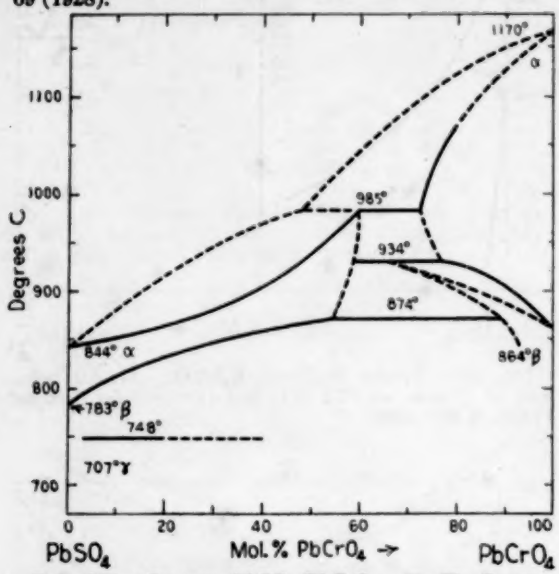

FIG. 229.—System $PbSO_4$–$PbCrO_4$. F. H. JAEGER AND H. C. GERMS, *Z. anorg. allgem. Chem.*, **93**, 119, 145 (1921); *Int. Critical Tables*, **4**, 52 (1928).

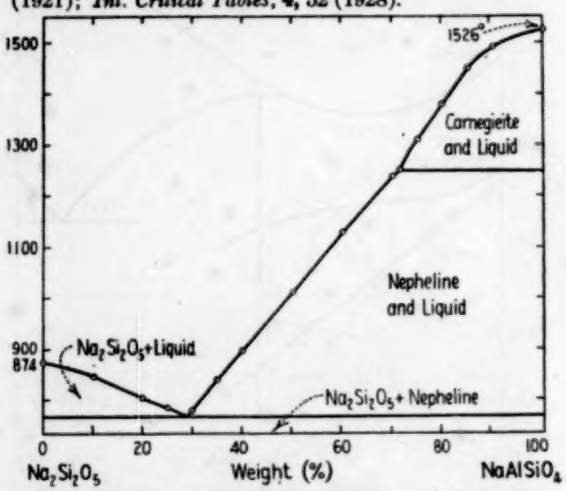

FIG. 233.—System $Na_2Si_2O_5$–$NaAlSiO_4$. C. F. TILLEY, *Mineralog. petrog. Mitt.*, **43**, 406–21 (1933); *Ceram. Abs.*, **13** [3] 72–73 (1934).

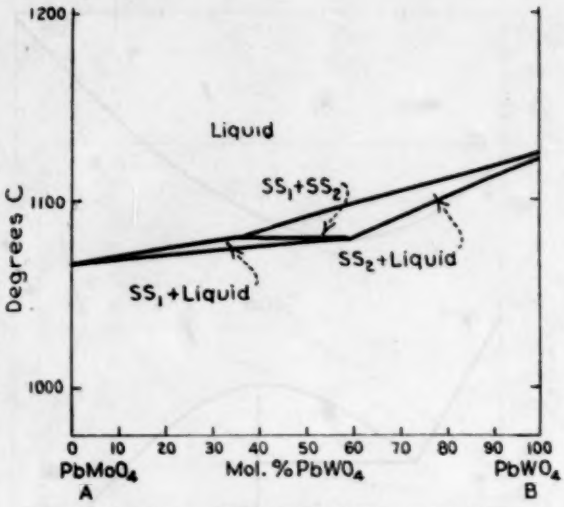

FIG. 230.—System $PbMoO_4$–$PbWO_4$. F. H. JAEGER AND H. C. GERMS, *Z. anorg. allgem. Chem.*, **119**, 145 (1921); *Int. Critical Tables*, **4**, 52 (1928).

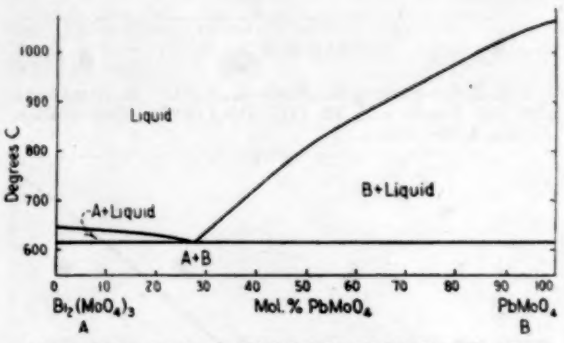

FIG. 231.—System $Bi_2(MoO_4)_3$–$PbMoO_4$. F. ZAMBONINI, *Gazz. chim. ital.*, **50** [II] 128 (1920); *Int. Critical Tables*, **4**, 48 (1928).

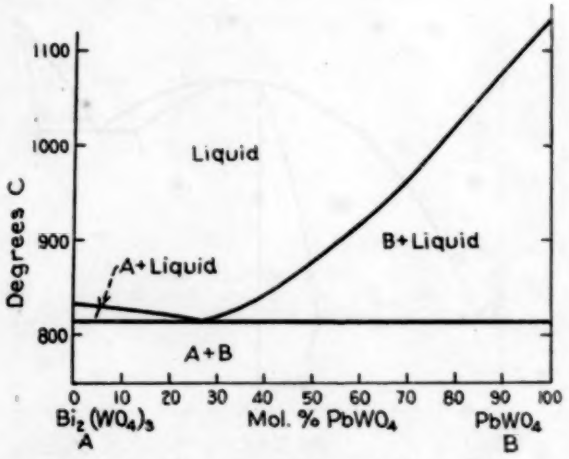

FIG. 232.—System $Bi_2(WO_4)_3$–$PbWO_4$. F. ZAMBONINI, *Gazz. chim. ital.*, **50** [II] 128 (1920); *Int. Critical Tables*, **4**, 48 (1928).

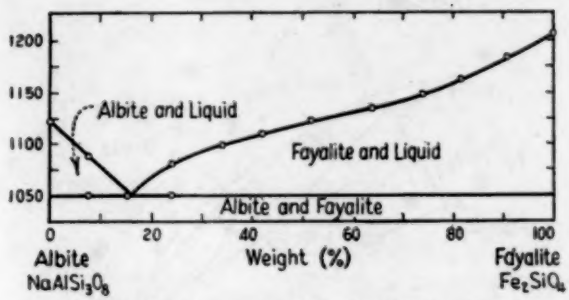

FIG. 234.—System albite ($NaAlSi_3O_8$)–fayalite (Fe_2SiO_4). N. L. BOWEN AND J. F. SCHAIRER, *Proc. Nat. Acad. Sci.*, **22** [6] 345–50 (1936).

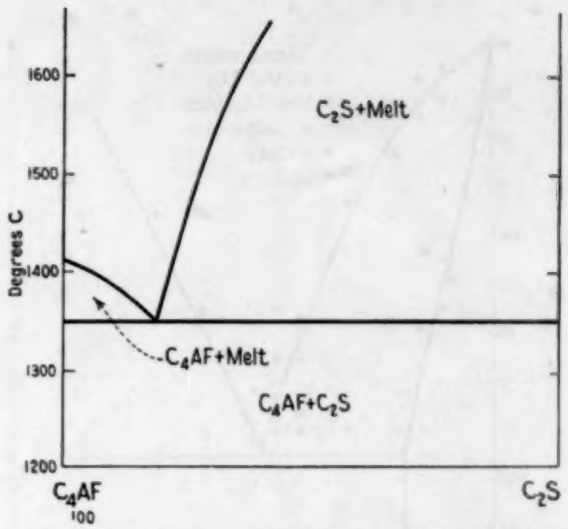

FIG. 235.—System $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$–$2CaO \cdot SiO_2$. F. M. LEA AND T. W. PARKER, *Phil. Trans. Roy. Soc.* [London], **234** [731] 13 (1934); *Ceram. Abs.*, **14** [7] 173 (1935). $C_4AF = 4CaO \cdot Al_2O_3 \cdot Fe_2O_3$–$2CaO \cdot SiO_2$. $C_2S = 2CaO \cdot SiO_2$.

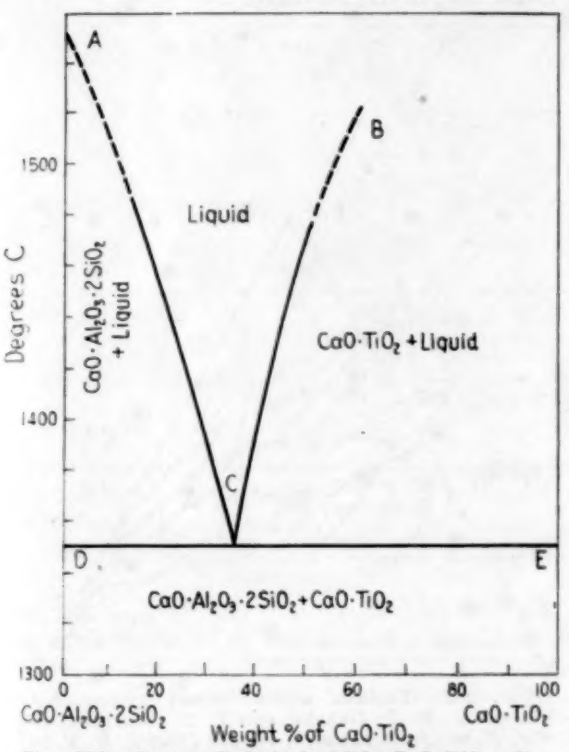

FIG. 236.—System $CaO \cdot Al_2O_3 \cdot 2SiO_2$–$CaO \cdot TiO_2$. USABURO NISIOKA, *Science Repts., Tôhoku Imp. Univ., Series 1*, **24**, 708 (1936); *Ceram. Abs.*, **15** [8] 258 (1936).

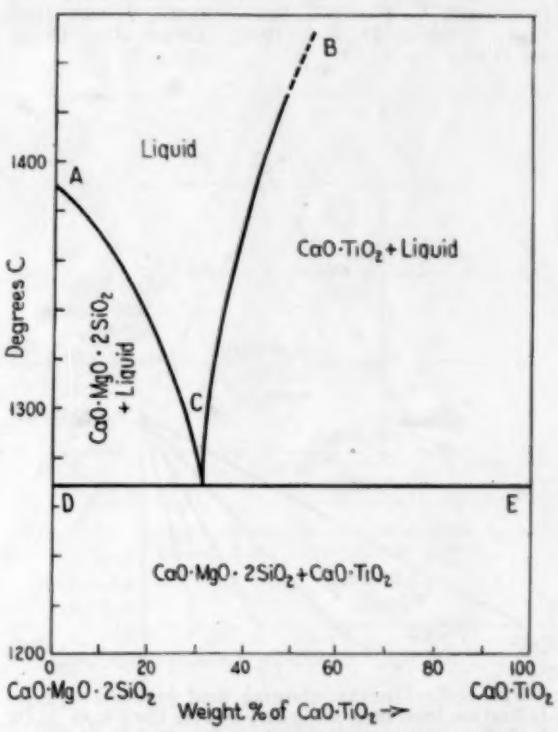

FIG. 237.—System $CaO \cdot MgO \cdot 2SiO_2$–$CaO \cdot TiO_2$. USABURO NISIOKA, *Science Repts., Tôhoku Imp. Univ., Series 1*, **24**, 715 (1936).

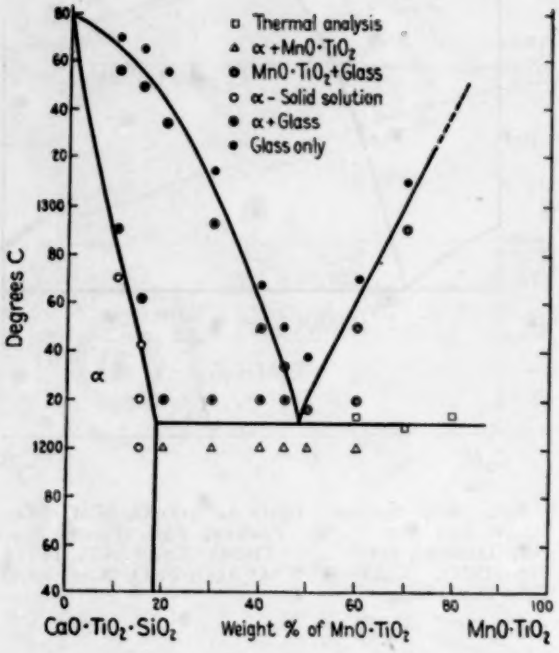

FIG. 238.—System $CaO \cdot TiO_2 \cdot SiO_2$–$MnO \cdot TiO_2$. K. IWASÉ AND U. NISIOKA, *Science Repts., Tôhoku Imp. Univ., Series 1*, **25**, 504 (1936); *Ceram. Abs.*, **16** [5] 161 (1937).

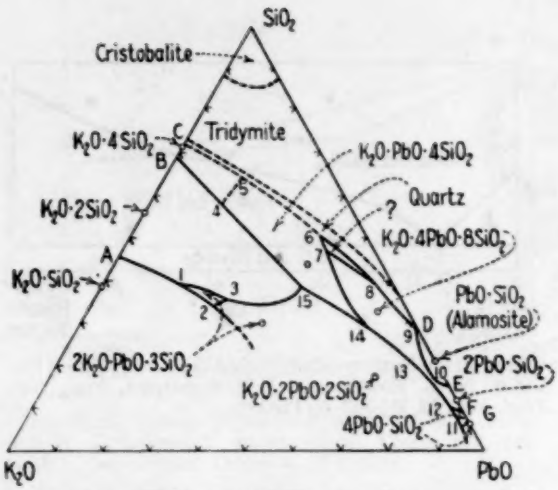

FIG. 241.—Fields of stability for the system K_2O–PbO–SiO_2. R. F. GELLER AND E. N. BUNTING, *Nat. Bur. Stand. Jour. Research*, **17**, 277–89 (1936); R. P. 911; *Ceram. Abs.*, **15** [11] 349 (1936).

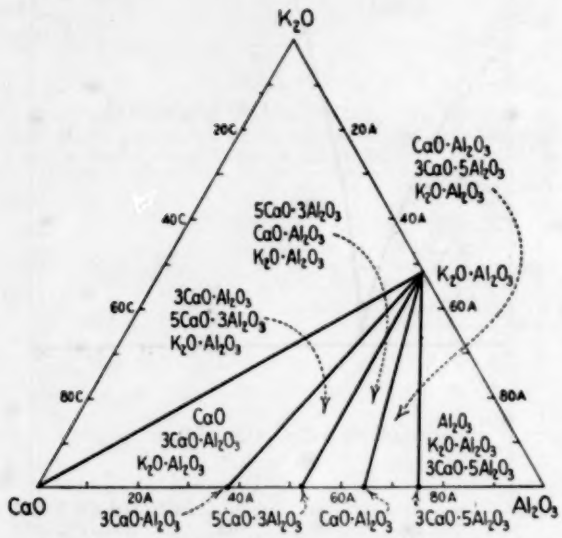

FIG. 239.—Diagram showing final products of crystallization from melt in ternary system CaO–K_2O–Al_2O_3. L. T. BROWNMILLER, *Amer. Jour. Sci.*, **29**, 260–77 (1935); *Ceram. Abs.*, **15** [9] 287–88 (1936).

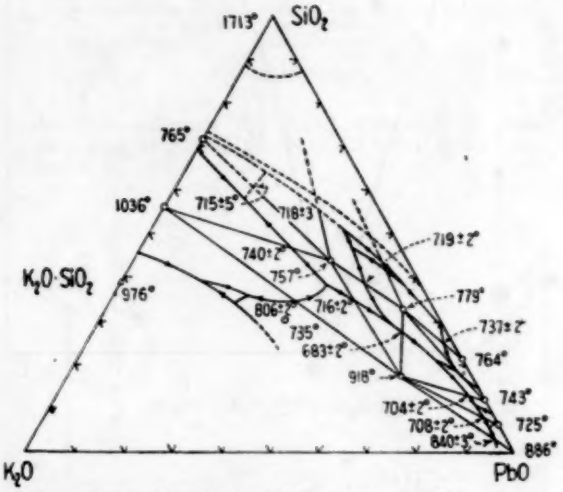

FIG. 242.—Tie-lines within ternary system K_2O–PbO–SiO_2. R. F. GELLER AND E. N. BUNTING, *Nat. Bur. Stand. Jour. Research*, **17**, 277 (1936); R. P. 911.

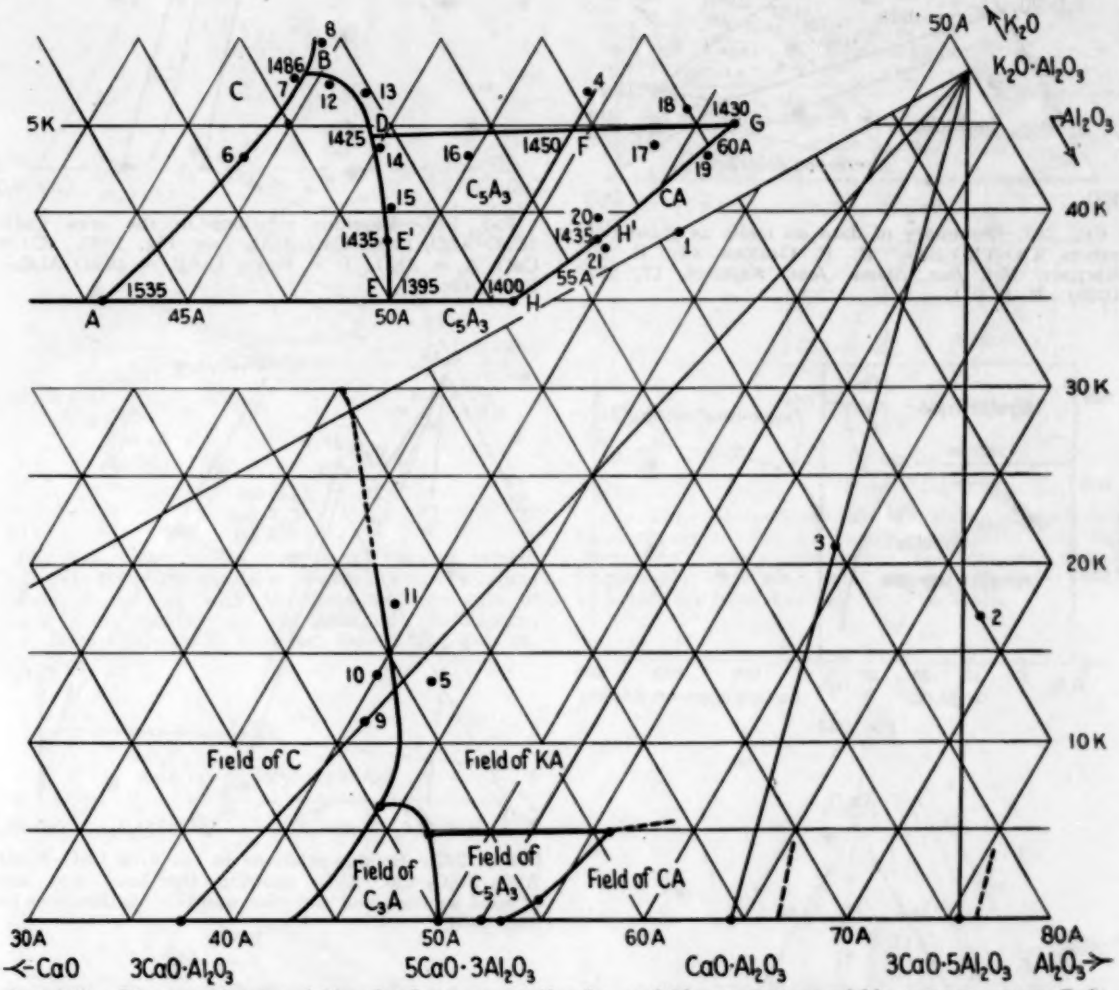

FIG. 240.—Diagram showing fields of primary crystallization and binary systems within ternary system CaO–K_2O–Al_2O_3. L. T. BROWNMILLER, *Amer. Jour. Sci.*, **29**, 260–77 (1935); *Ceram. Abs.*, **15** [9] 287–88 (1936).

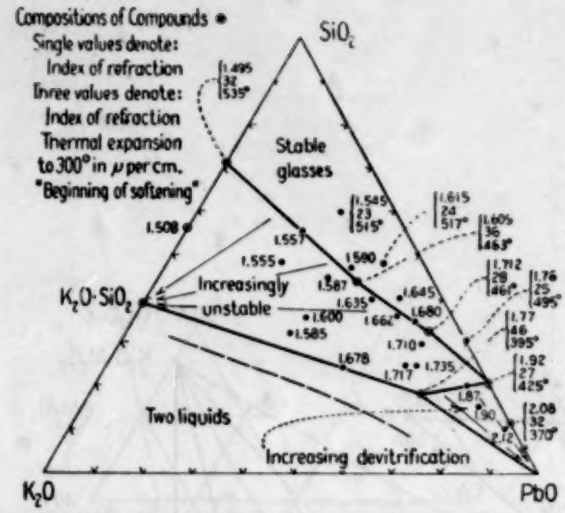

FIG. 243.—Summary of data on melts as glasses of system K_2O–PbO–SiO_2. R. F. GELLER AND E. N. BUNTING, *Nat. Bur. Stand. Jour. Research*, **17**, 277 (1936); R. P. 911.

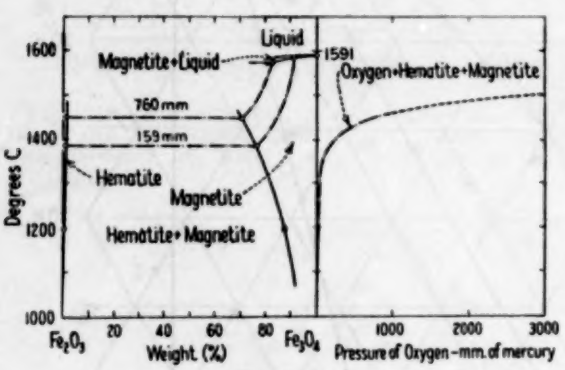

FIG. 244.

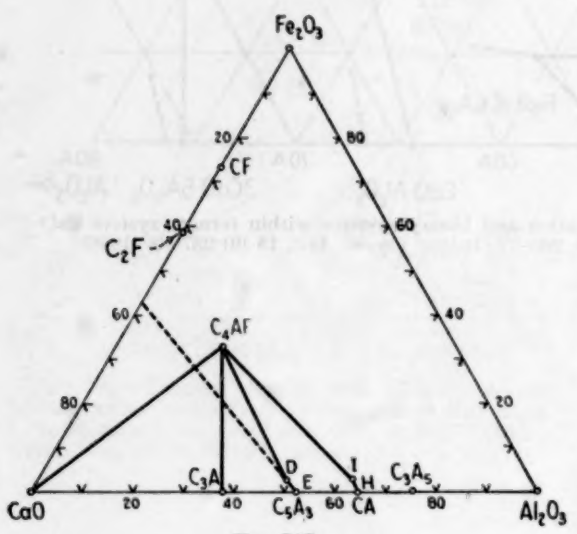

FIG. 245.

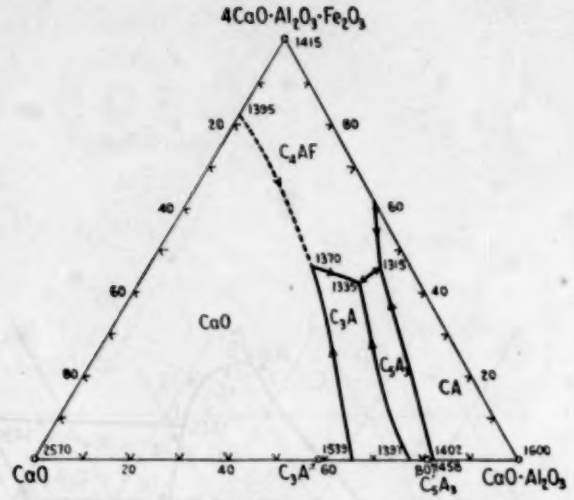

FIG. 246.—Liquidus relations in the area CaO–$4CaO·Al_2O_3·Fe_2O_3$–$CaO·Al_2O_3$ (see Fig. 245). C = CaO, A = Al_2O_3, F = Fe_2O_3, C_4AF = $4CaO·Al_2O_3·Fe_2O_3$, etc.

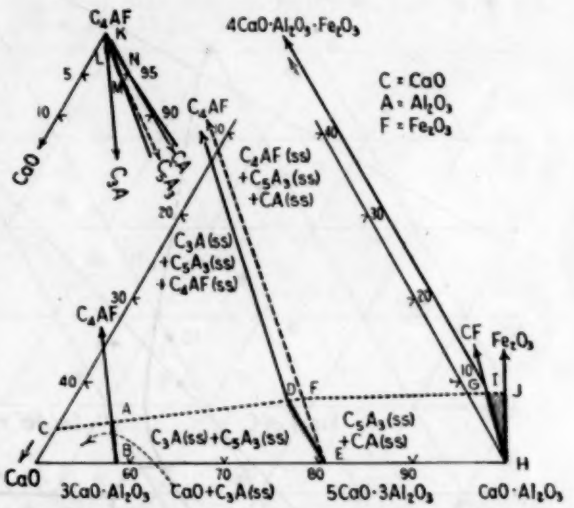

FIG. 247.—Solidus relations in the area CaO–$4CaO·Al_2O_3·Fe_2O_3$–$CaO·Al_2O_3$ showing the lines and areas of solid solution and the joins and conjugation lines (see Fig. 246).

FIG. 244.—System Fe_3O_4–Fe_2O_3–O_2. J. W. GREIG, E. POSNJAK, H. E. MERWIN, AND R. B. SOSMAN, *Amer. Jour. Sci.*, **30**, 239–316 (1935); *Ceram. Abs.*, **15** [2] 74 (1936). (Right-hand diagram shows the pressure of oxygen with which magnetite and hematite can coexist in stable equilibrium.)

FIG. 245.—Relation of the area CaO–$4CaO·Al_2O_3$–Fe_2O_3–$CaO·Al_2O_3$ to the ternary system CaO–Fe_2O_3–Al_2O_3. H. F. MCMURDIE, *Jour. Research Nat. Bur. Stand.*, **18** [4] 475–84 (1937); R. P. 987; *Ceram. Abs.*, **16** [6] 189 (1937). Liquidus relations in above area are shown in Fig. 246; solidus relations in Fig. 247. C = CaO, A = Al_2O_3, F = Fe_2O_3, C_4AF = $4CaO·Al_2O_3·Fe_2O_3$, etc.

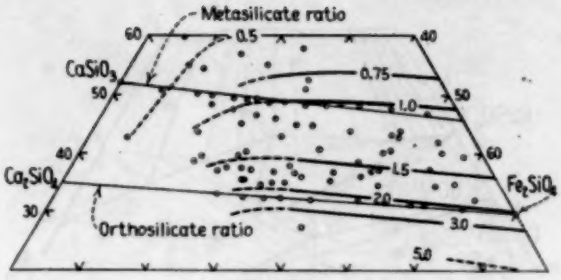

FIG. 248.

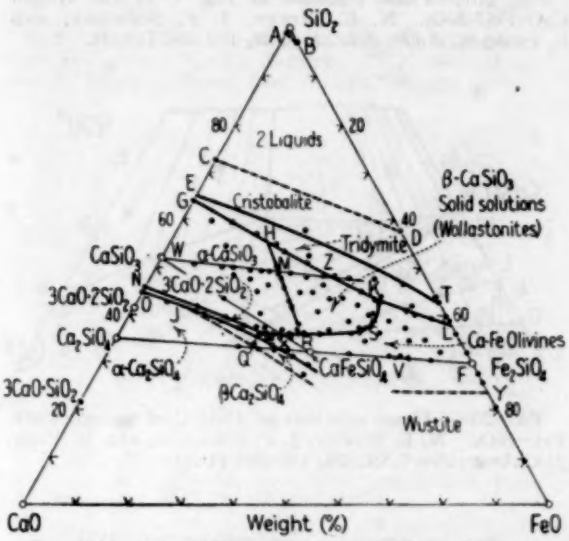

FIG. 249.—Equilibrium diagram of part of system CaO–FeO–SiO_2 showing fields of stability of crystalline phases in contact with liquid. (Small amount of Fe_2O_3 in all liquids; see Fig. 248.) N. L. BOWEN, J. F. SCHAIRER, AND E. POSNJAK, *Amer. Jour. Sci.*, **26**, 193–284 (1933).

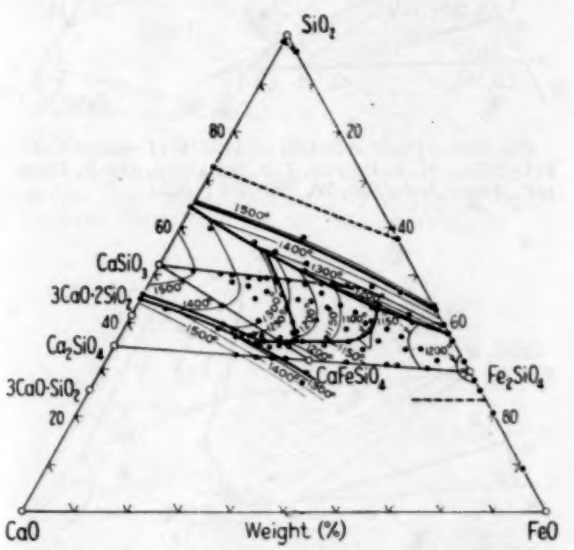

FIG. 250.—Isotherms of system CaO–FeO–SiO_2. N. L. BOWEN, J. F. SCHAIRER, AND E. POSNJAK, *Amer. Jour. Sci.*, **26**, 193–284 (1933).

FIG. 248.—Diagram showing the manner of variation of Fe_2O_3 content of liquid mixtures of CaO, SiO_2, and Fe oxide in equilibrium with metallic iron. The number on any curve gives the approximate weight per cent of Fe_2O_3 at the liquidus temperature for a mixture represented by any point on that curve. N. L. BOWEN, J. F. SCHAIRER, AND E. POSNJAK, *Amer. Jour. Sci.*, **26**, 193–284 (1933).

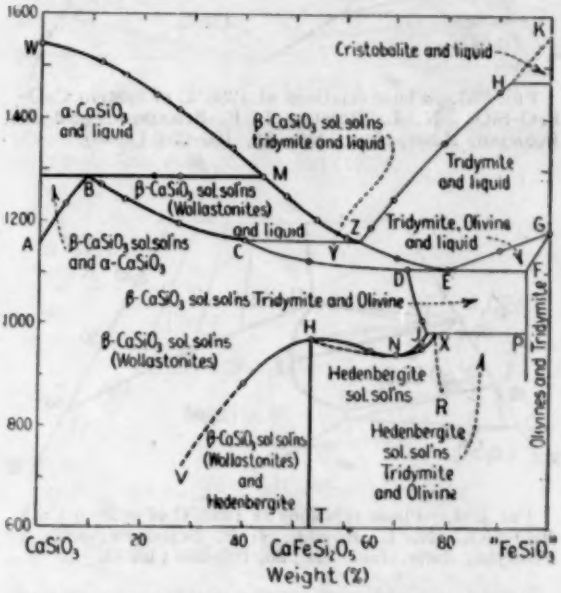

FIG. 251.—Metasilicate join in system CaO–FeO–SiO_2. Heavy curves refer to binary equilibrium and light curves to ternary equilibrium (binary and ternary, respectively, only when small amounts of Fe_2O_3 present in liquids are treated as FeO (see Fig. 248)).

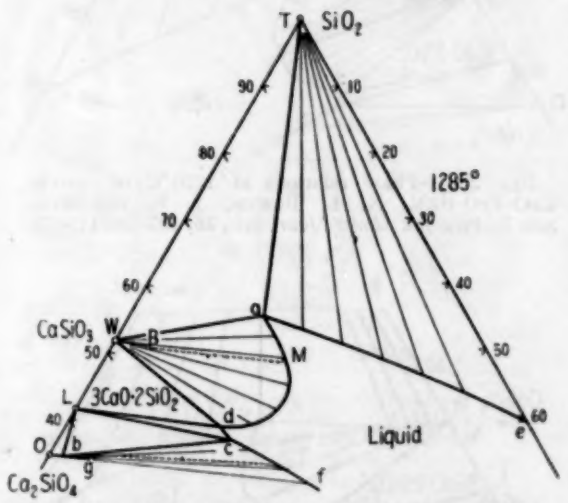

FIG. 252.—Phase relations at 1285°C of system CaO–FeO–SiO_2. N. L. BOWEN, J. F. SCHAIRER, AND E. POSNJAK, *Amer. Jour. Sci.*, **26**, 193–284 (1933).

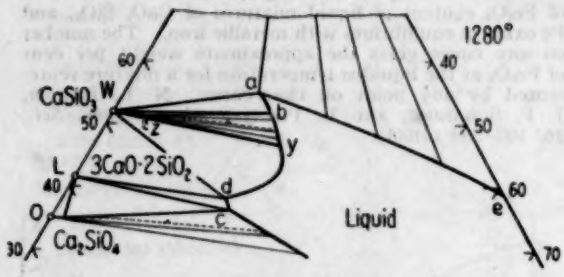

FIG. 253.—Phase relations at 1280°C of system CaO–FeO–SiO_2. N. L. BOWEN, J. F. SCHAIRER, AND E. POSNJAK, *Amer. Jour. Sci.*, **26**, 193–284 (1933).

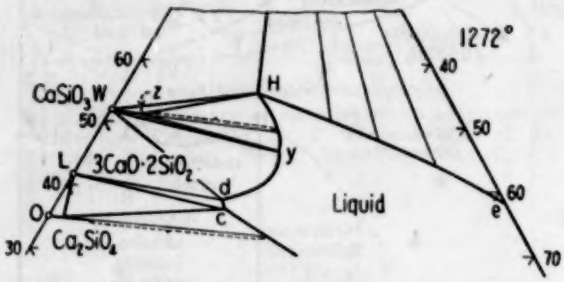

FIG. 254.—Phase relations at 1272°C of system CaO–FeO–SiO_2. N. L. BOWEN, J. F. SCHAIRER, AND E. POSNJAK, *Amer. Jour. Sci.*, **26**, 193–284 (1933).

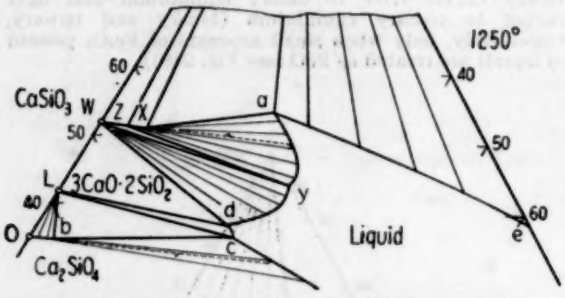

FIG. 255.—Phase relations at 1250°C of system CaO–FeO–SiO_2. N. L. BOWEN, J. F. SCHAIRER, AND E. POSNJAK, *Amer. Jour. Sci.*, **26**, 193–284 (1933).

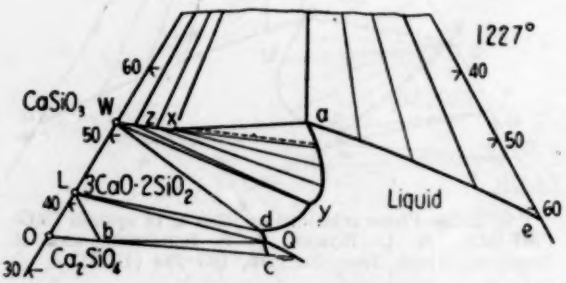

FIG. 256.—Phase relations at 1227°C of system CaO–FeO–SiO_2. N. L. BOWEN, J. F. SCHAIRER, AND E. POSNJAK, *Amer. Jour. Sci.*, **26**, 193–284 (1933).

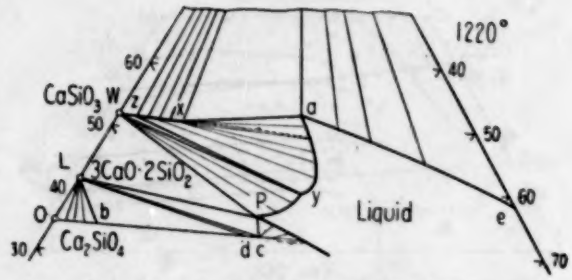

FIG. 257.—Phase relations at 1220°C of the system CaO–FeO–SiO_2. N. L. BOWEN, J. F. SCHAIRER, AND E. POSNJAK, *Amer. Jour. Sci.*, **26**, 193–284 (1933).

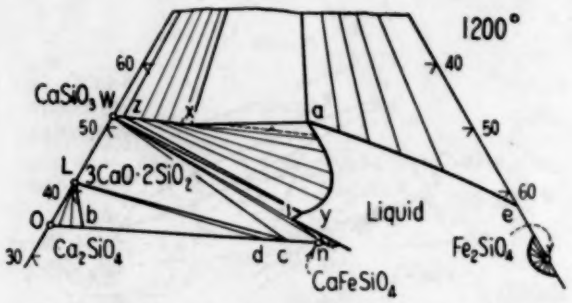

FIG. 258.—Phase relations at 1200°C of system CaO–FeO–SiO_2. N. L. BOWEN, J. F. SCHAIRER, AND E. POSNJAK, *Amer. Jour. Sci.*, **26**, 193–284 (1933).

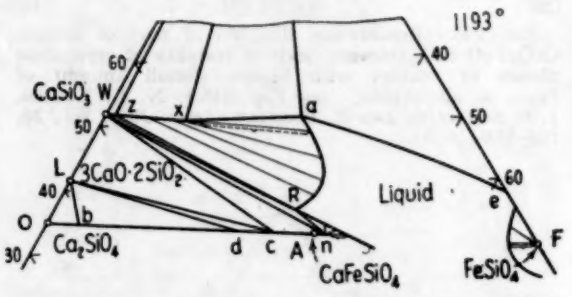

FIG. 259.—Phase relations at 1193°C of system CaO–FeO–SiO_2. N. L. BOWEN, J. F. SCHAIRER, AND E. POSNJAK, *Amer. Jour. Sci.*, **26**, 193–284 (1933).

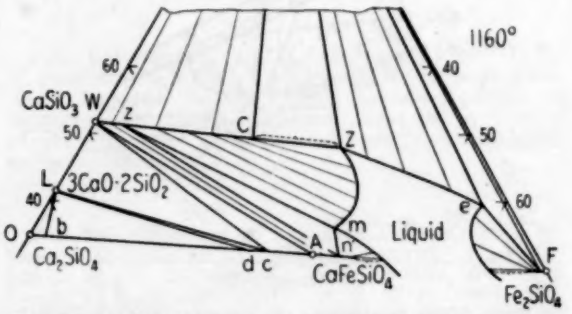

FIG. 260.—Phase relations at 1160°C of system CaO–FeO–SiO_2. N. L. BOWEN, J. F. SCHAIRER, AND E. POSNJAK, *Amer. Jour. Sci.*, **26**,193–284 (1933).

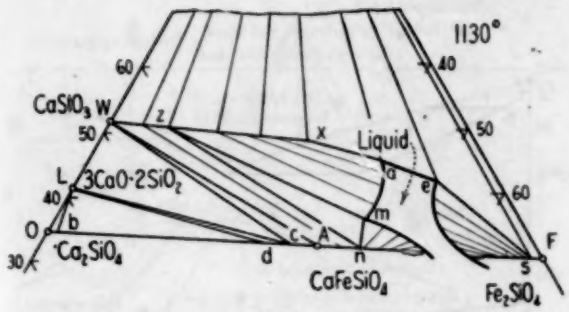

FIG. 261.—Phase relations at 1130°C of system CaO–FeO–SiO_2. N. L. BOWEN, J. F. SCHAIRER, AND E. POSNJAK, *Amer. Jour. Sci.*, **26**, 193–284 (1933).

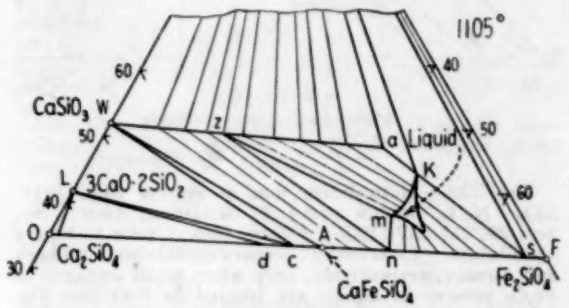

FIG. 262.—Phase relations at 1105°C of system CaO–FeO–SiO_2. N. L. BOWEN, J. F. SCHAIRER, AND E. POSNJAK, *Amer. Jour. Sci.*, **26**, 193–284 (1933).

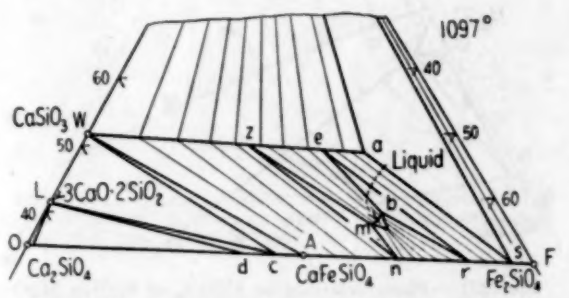

FIG. 263.—Phase relations at 1097°C of system CaO–FeO–SiO_2. N. L. BOWEN, J. F. SCHAIRER, AND E. POSNJAK, *Amer. Jour. Sci.*, **26**, 193–284 (1933).

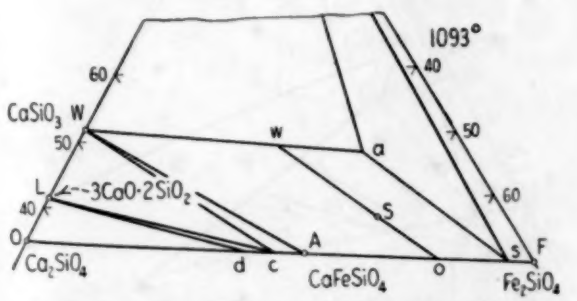

FIG. 264.—Phase relations at 1093°C of system CaO–FeO–SiO_2. N. L. BOWEN, J. F. SCHAIRER, AND E. POSNJAK, *Amer. Jour. Sci.*, **26**, 193–284 (1933).

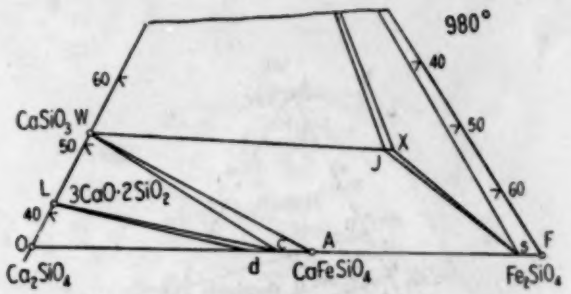

FIG. 265.—Phase relations at 980°C of system CaO–FeO–SiO_2. N. L. BOWEN, J. F. SCHAIRER, AND E. POSNJAK, *Amer. Jour. Sci.*, **26**, 193–284 (1933).

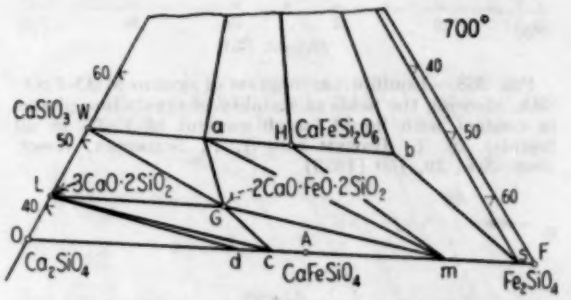

FIG. 266.—Phase relations at 700°C of the system CaO–FeO–SiO_2. N. L. BOWEN, J. F. SCHAIRER, AND E. POSNJAK, *Amer. Jour. Sci.*, **26**, 193–284 (1933).

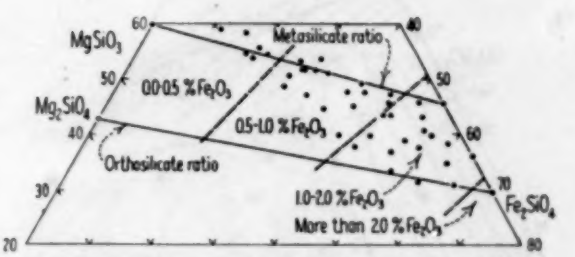

FIG. 267.—Diagram showing the approximate Fe_2O_3 content of liquid mixtures of MgO, SiO_2, and Fe oxide, in equilibrium with metallic iron. (Compare Fig. 268.) N. L. BOWEN AND J. F. SCHAIRER, *Amer. Jour. Sci.*, **29**, 159 (1935); *Ceram. Abs.*, **15** [9] 288 (1936).

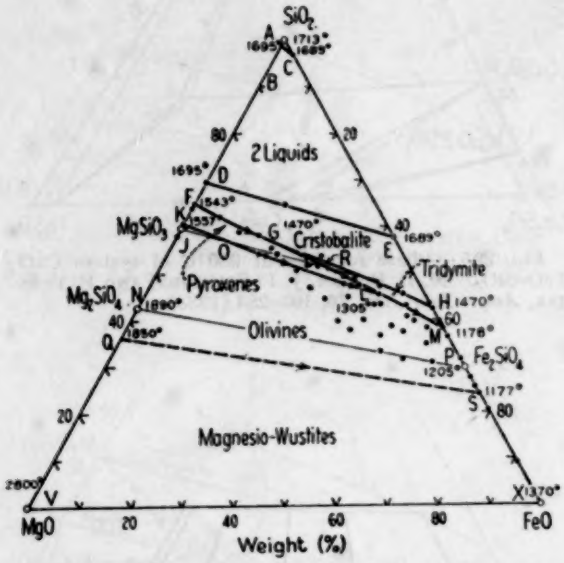

FIG. 268.—Equilibrium diagram of system MgO–FeO–SiO_2, showing the fields of stability of crystalline phases in contact with liquid (small amount of Fe_2O_3 in all liquids). N. L. BOWEN AND J. F. SCHAIRER, *Amer. Jour. Sci.*, **29**, 159 (1935).

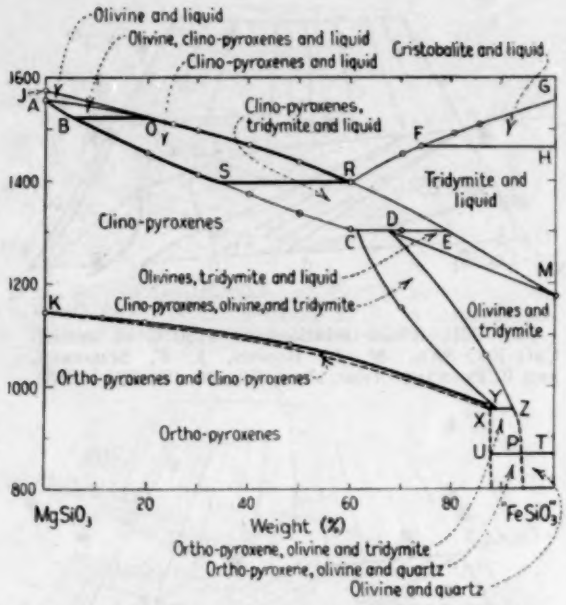

FIG. 270.—Metasilicate join in system MgO–FeO–SiO_2. N. L. BOWEN AND J. F. SCHAIRER, *Amer. Jour. Sci.*, **29**, 151–217 (1935). *Heavy curves:* refer to binary equilibrium. *Light curves:* ternary equilibrium. (Binary and ternary, respectively, only when small amounts of Fe_2O_3 present in liquids are treated as FeO (see Fig. 267).)

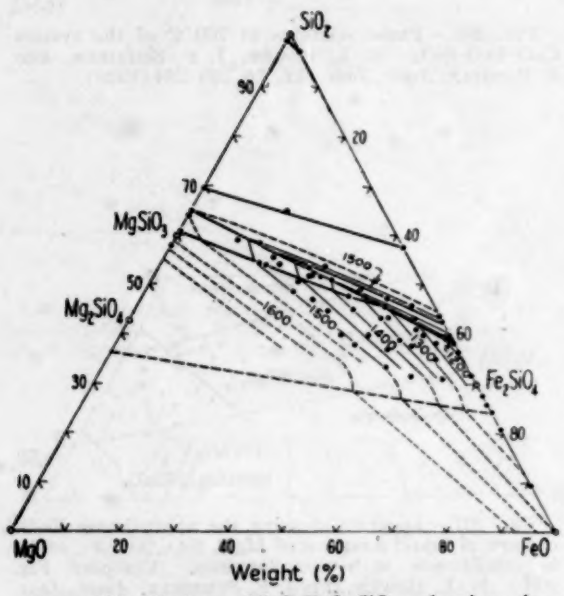

FIG. 269.—System MgO–FeO–SiO_2 showing isotherms. N. L. BOWEN AND J. F. SCHAIRER, *Amer. Jour. Sci.*, **29**, 151–217 (1935). (Compare Figs. 267 and 268.)

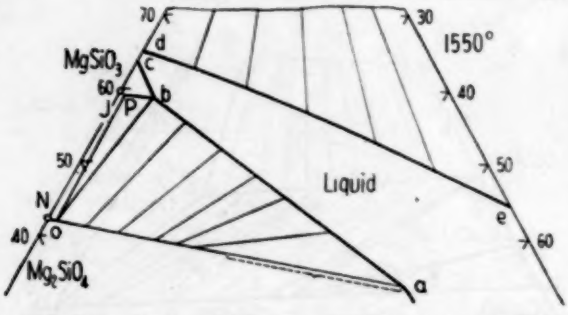

FIG. 271.—Phase relations at 1550°C of system MgO–FeO–SiO_2. N. L. BOWEN AND J. F. SCHAIRER, *Amer. Jour. Sci.*, **29**, 151–217 (1935).

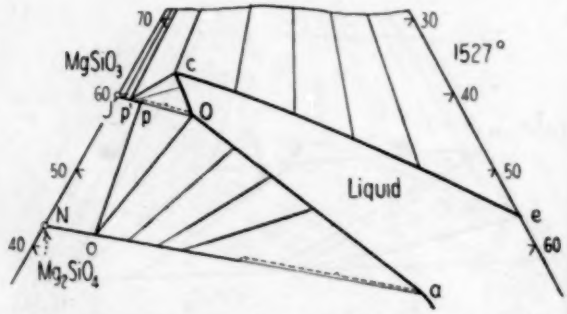

FIG. 272.—Phase relations at 1527°C of system MgO–FeO–SiO_2. N. L. BOWEN AND J. F. SCHAIRER, *Amer. Jour. Sci.*, **29**, 151–217 (1935).

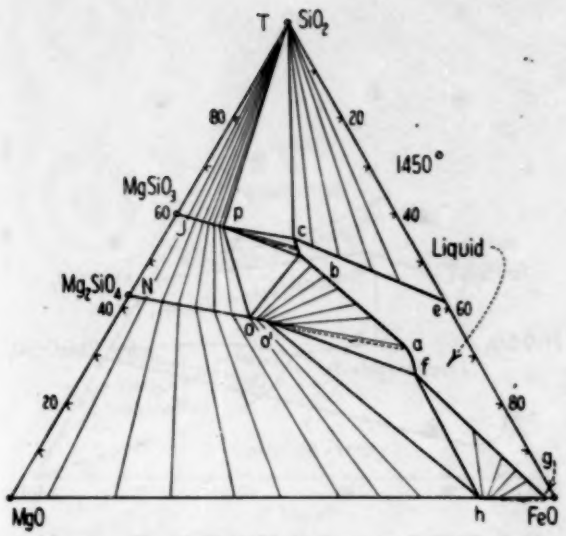

FIG. 273.—Phase relations at 1450°C of system MgO–FeO–SiO_2. N. L. BOWEN AND J. F. SCHAIRER, *Amer. Jour. Sci.*, **29**, 151–217 (1935).

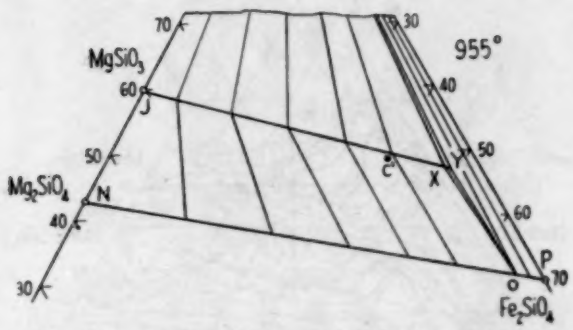

FIG. 276.—Phase relations at 955°C of system MgO–FeO–SiO_2. N. L. BOWEN AND J. F. SCHAIRER, *Amer. Jour. Sci.*, **29**, 151–217 (1935).

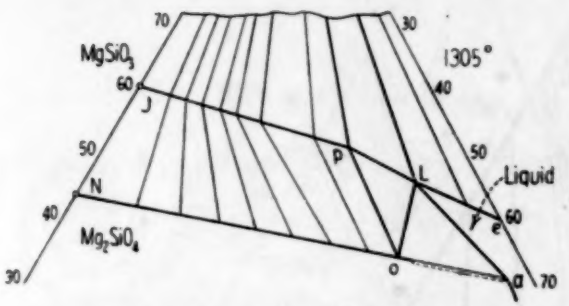

FIG. 274.—Phase relations at 1305°C of system MgO–FeO–SiO_2. N. L. BOWEN AND J. F. SCHAIRER, *Amer. Jour. Sci.*, **29**, 151–217 (1935).

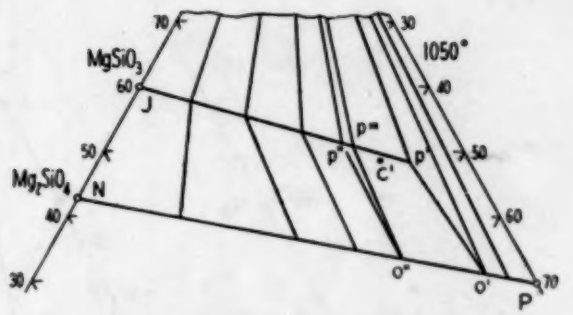

FIG. 277.—Phase relations at 1050°C of system MgO–FeO–SiO_2. N. L. BOWEN AND J. F. SCHAIRER, *Amer. Jour. Sci.*, **29**, 151–217 (1935).

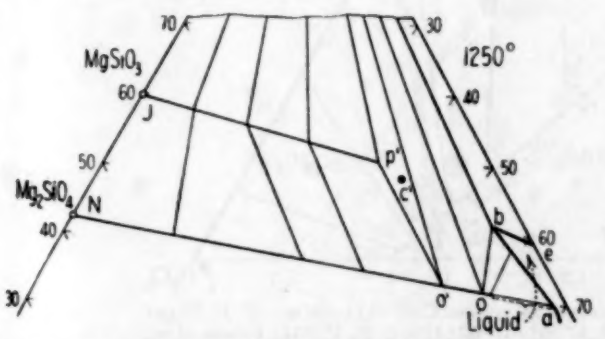

FIG. 275.—Phase relations at 1250°C of system MgO–FeO–SiO_2. N. L. BOWEN AND J. F. SCHAIRER, *Amer. Jour. Sci.*, **29**, 151–217 (1935).

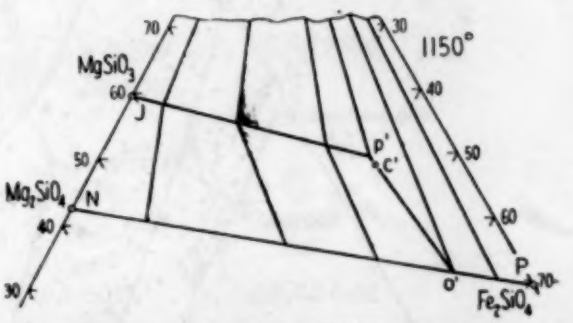

FIG. 278.—Phase relations at 1150°C of system MgO–FeO–SiO_2. N. L. BOWEN AND J. F. SCHAIRER, *Amer. Jour. Sci.*, **29**, 151–217 (1935).

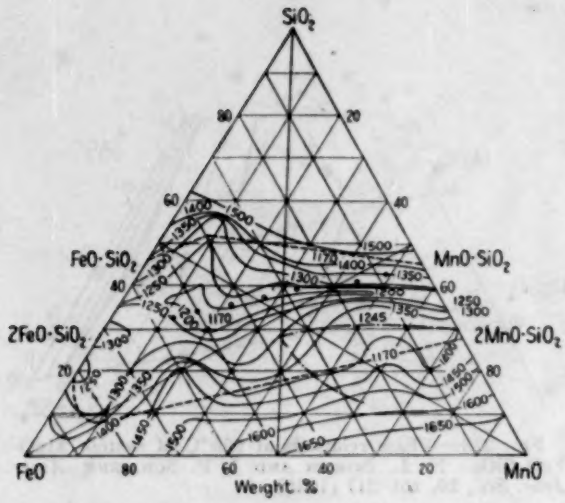

FIG. 279.—Liquidus isotherms in the system FeO–MnO–SiO_2. W. R. MADDOCKS, *Iron & Steel Inst., Carnegie Scholarship Mem.*, **24**, 61 (1935); *Ceram. Abs.*, **15** [5] 169 (1936).

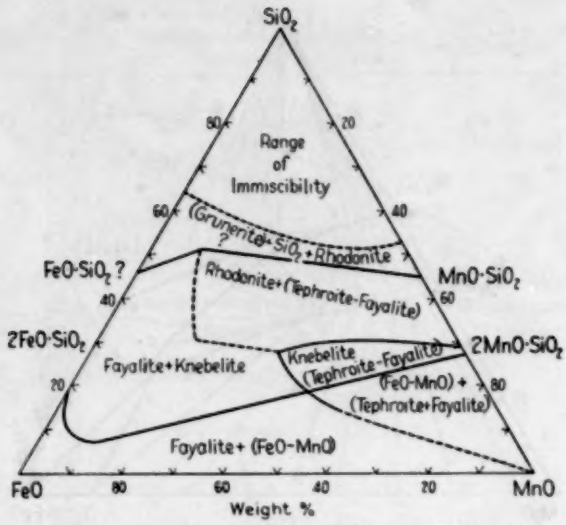

FIG. 280.—System FeO–MnO–SiO_2. W. R. MADDOCKS, *Iron & Steel Inst., Carnegie Scholarship Mem.*, **24**, 64 (1935).

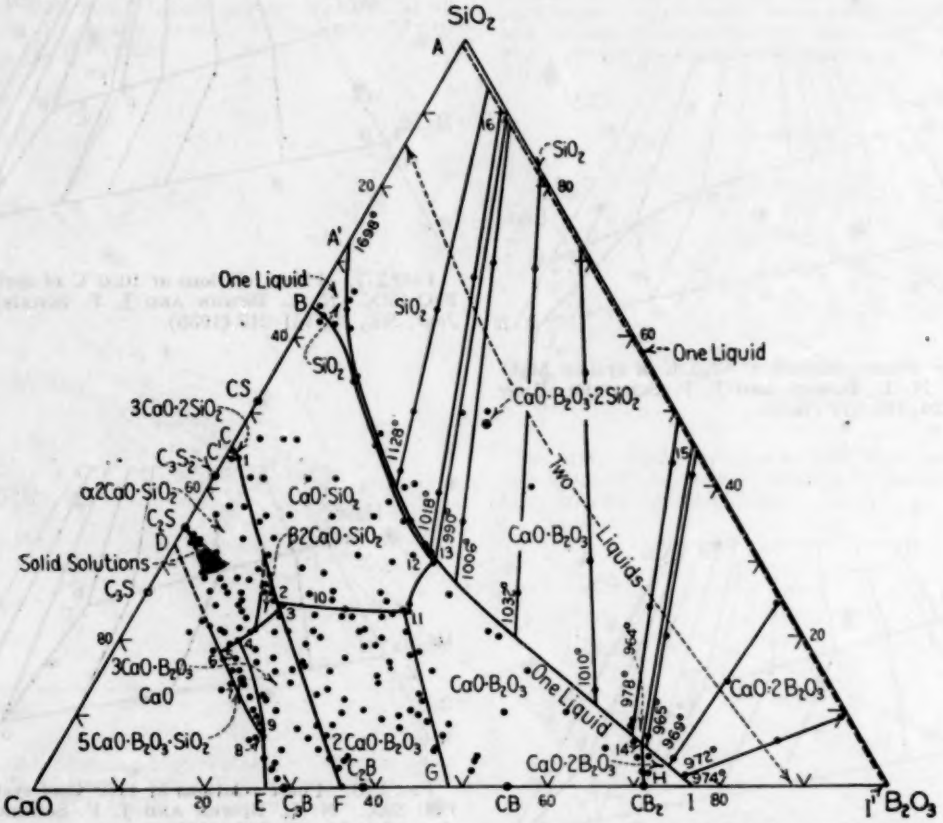

FIG. 281.—Fields of stability of various compounds in system CaO–B_2O_3–SiO_2. E. P. FLINT AND L. S. WELLS, *Nat. Bur. Stand. Jour. Research*, **17** [5] 727–52 (1936); R. P. 941; *Ceram. Abs.*, **16** [2] 75 (1937). Dots represent compositions investigated. (Compare Fig. 285, p. 142.)

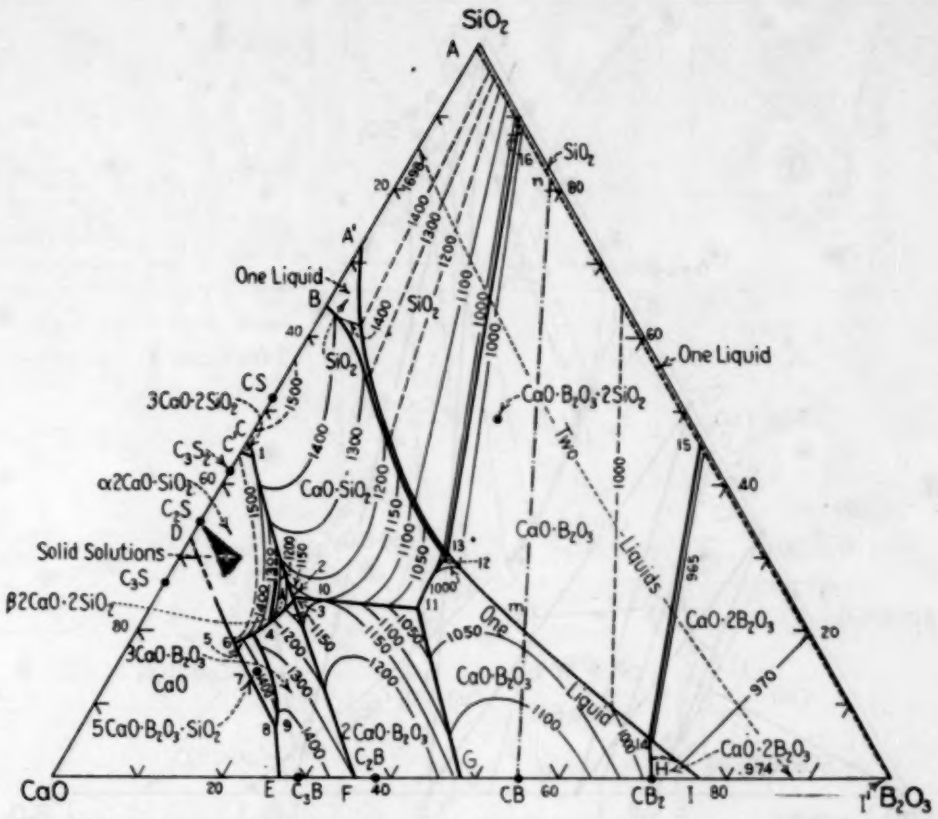

FIG. 282.—Isotherms showing temperatures of complete melting in system CaO–B_2O_3–SiO_2. E. P. FLINT AND L. S. WELLS, *Nat. Bur. Stand. Jour. Research*, **17** [5] 727–52 (1936); R. P. 941.

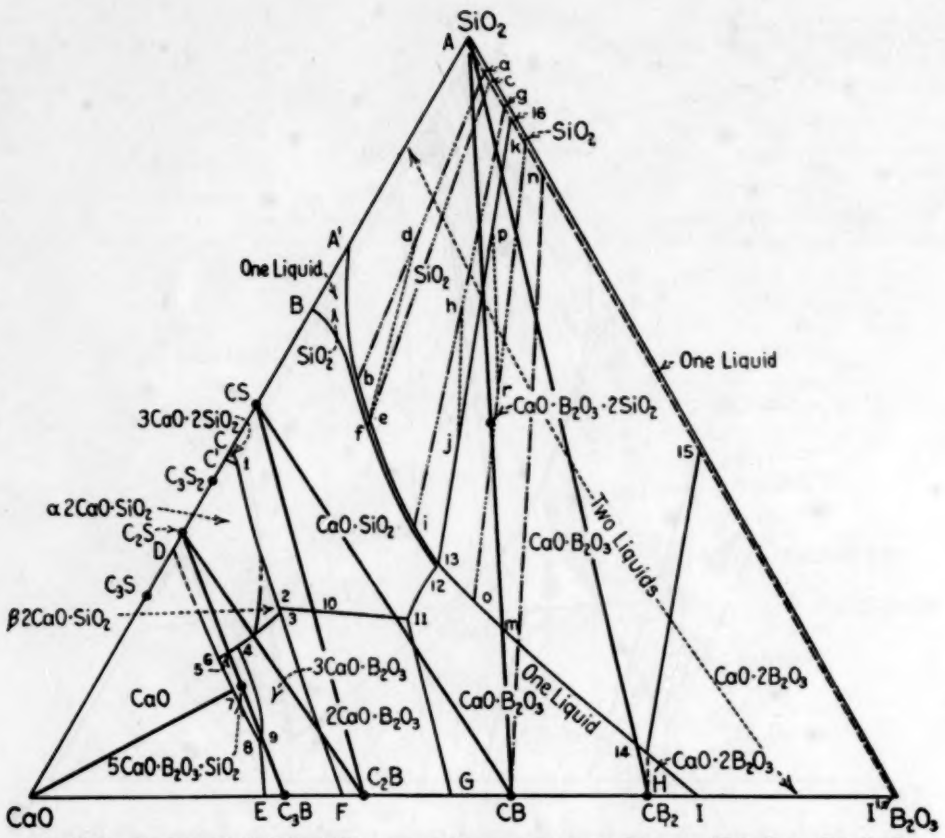

FIG. 283.—System CaO–B_2O_3–SiO_2. E. P. FLINT AND L. S. WELLS, *Nat. Bur. Stand. Jour. Research*, **17** [5] 727–52 (1936); R. P. 941. Compositions, triangles, and some typical crystallization paths in the two-liquid area.

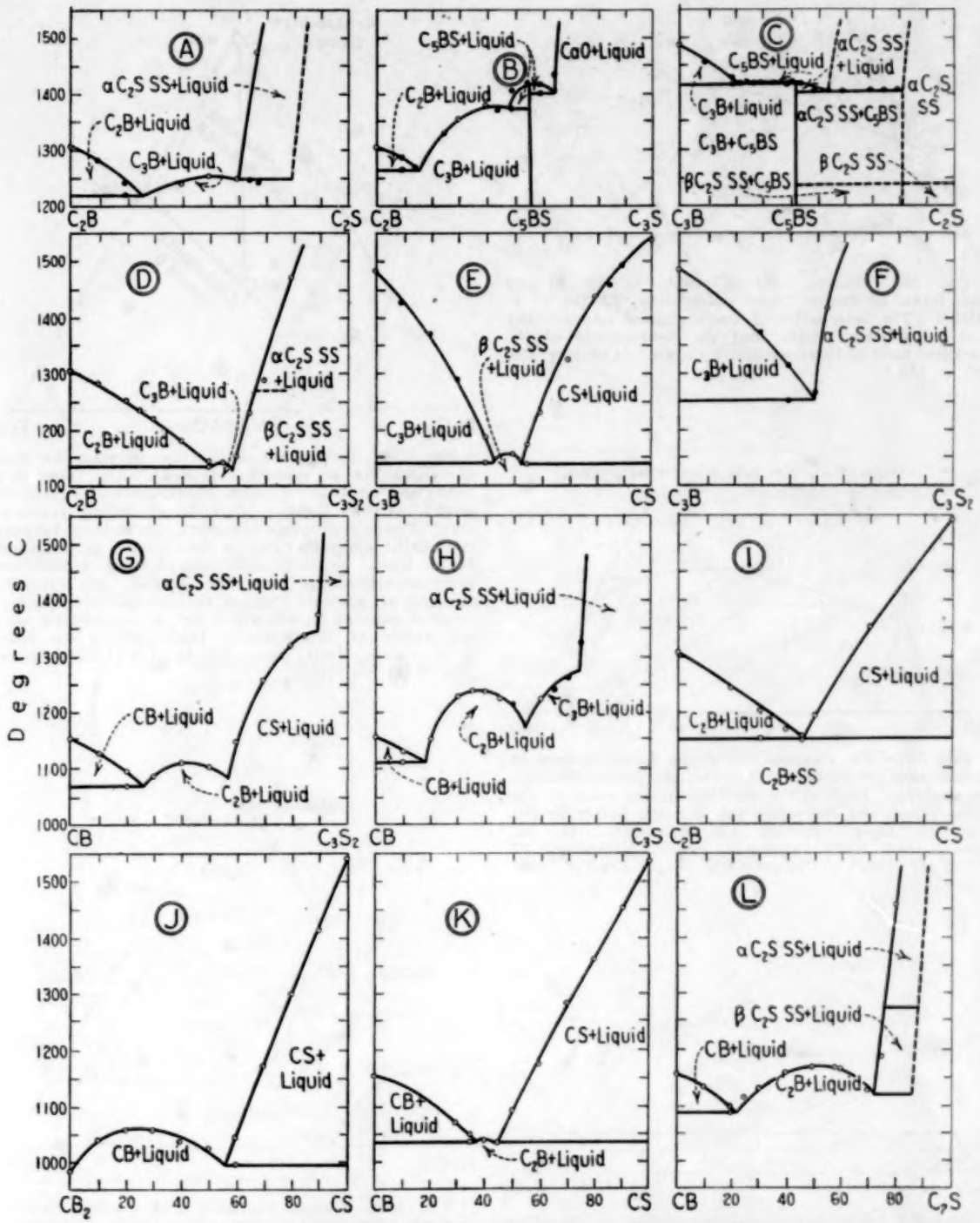

FIG. 284.—Binary and pseudobinary systems investigated in system $CaO–B_2O_3–SiO_2$. E. P. FLINT AND L. S. WELLS, *Nat. Bur. Stand. Jour. Research*, **17** [5] 727–52 (1936); R. P. 941; *Ceram. Abs.*, **16** [2] 75 (1937). C = CaO, B = B_2O_3, S = SiO_2, C_5BS = $5CaO \cdot B_2O_3 \cdot SiO_2$, etc.

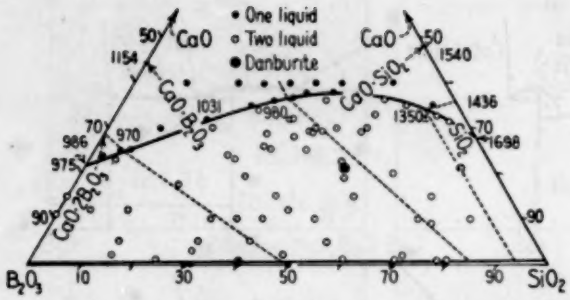

FIG. 285.—System CaO–B_2O_3–SiO_2. G. W. MOREY AND EARL INGERSON, *Amer. Mineralog.*, **22** [1] 37–47 (1932). The boundaries of the region of immiscibility and the adjacent fields, and the compositions of the mixtures used in their study are shown. (Compare Fig. 281, p. 138.)

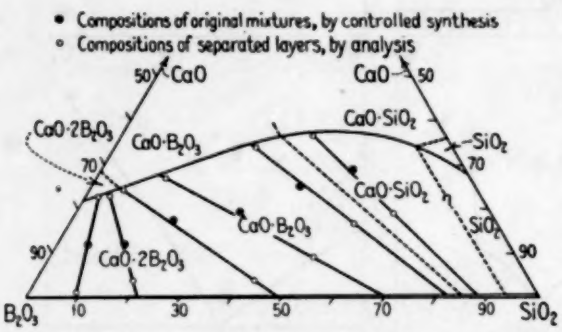

FIG. 286.—The compositions of the mixtures used in determining the tie-lines and of the two layers obtained for analysis. Each of the liquids contains some of the other phase, but the separation is much better in the CaO-rich layer. System CaO–B_2O_3–SiO_2. G. W. MOREY AND EARL INGERSON, *Amer. Mineralog.*, **22** [1] 37–47 (1932). (Compare Fig. 281, p. 138.)

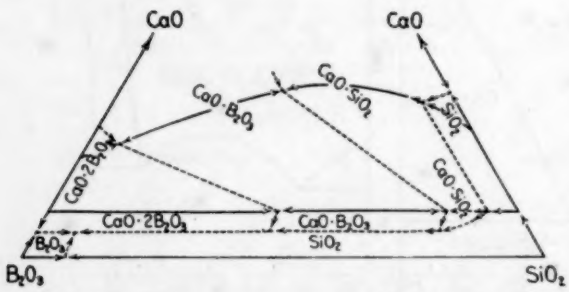

FIG. 287.—Diagrammatic representation of the phase equilibrium relationships in the ternary system CaO–B_2O_3–SiO_2, adjacent to the region of immiscibility. G. W. MOREY AND EARL INGERSON, *Amer. Mineralog.*, **22** [1] 37–47 (1932). (Compare Fig. 281, p. 138.)

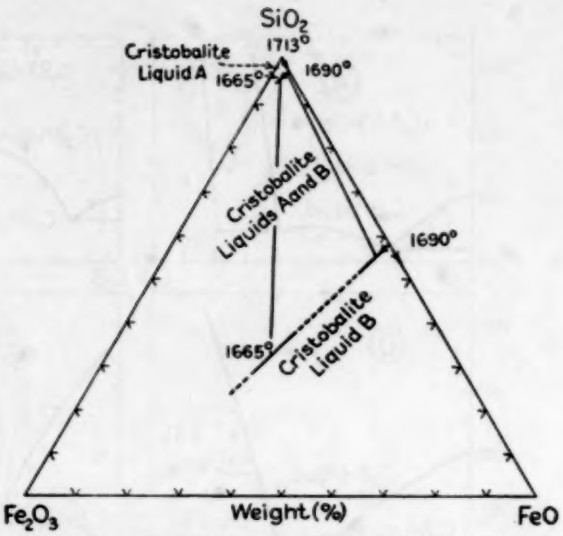

FIG. 288.—Incomplete equilibrium diagram for field of cristobalite in system FeO–Fe_2O_3–SiO_2. This is a projection on base of solid temperature-concentration model. Arrows indicate direction of falling temperature. Points on surface represent equilibrium between cristobalite and either one or two liquids as indicated. Light lines, crossing field representing equilibrium between cristobalite and two liquids, are tie-lines; two only are shown. Ends of tie-lines indicate compositions of pairs of liquids which are in equilibrium with cristobalite at temperatures corresponding to lines. J. W. GREIG, *Amer. Jour. Sci.*, **14**, 474 (1927); *Ceram. Abs.* **7** [2] 104 (1928).

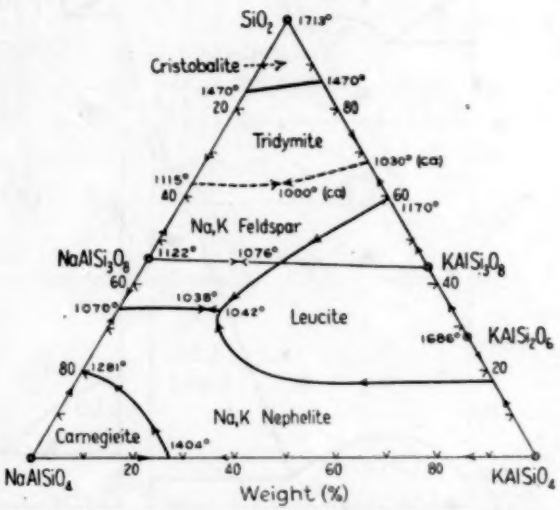

FIG. 290.—System $NaAlSiO_4$–$KAlSiO_4$–SiO_2 (arrows indicate falling temperature; concentric circles indicate composition of a compound). J. F. SCHAIRER AND N. L. BOWEN, *Trans. Amer. Geophysical Union, 16th Ann. Meeting*, pp. 325–28 (1935).

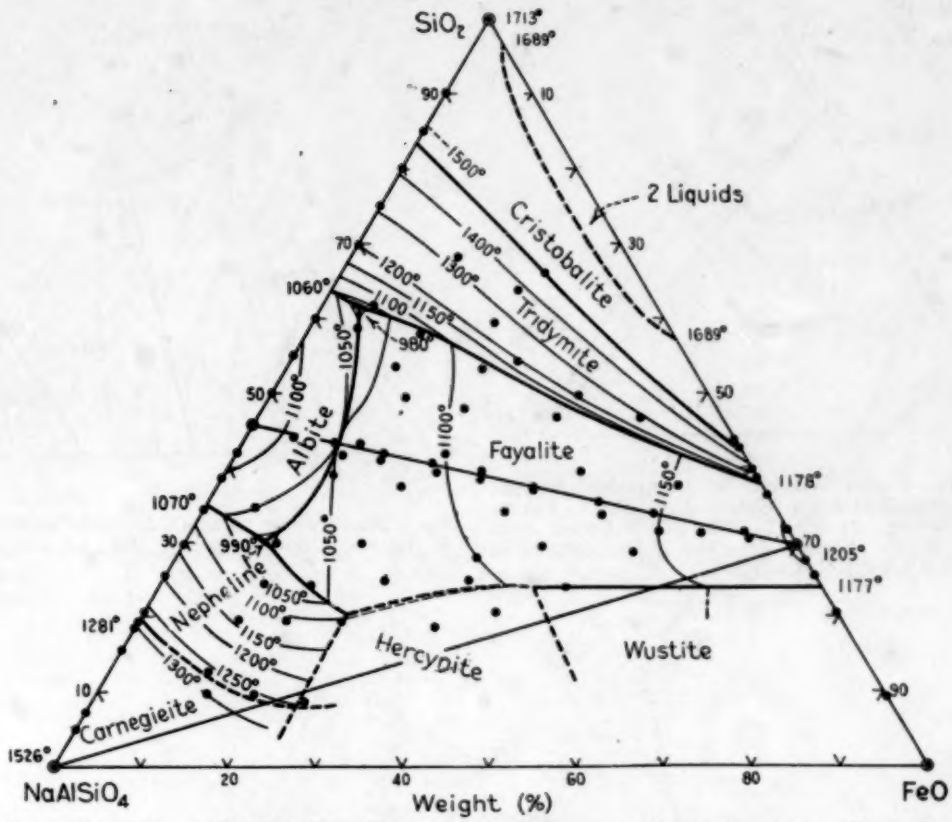

FIG. 289.—System $NaAlSiO_4$–FeO–SiO_2. N. L. BOWEN AND J. F. SCHAIRER. Hercynite equilibria nonternary. N. L. BOWEN, *Amer. Jour. Sci.*, **33**, 1–21 (1937).

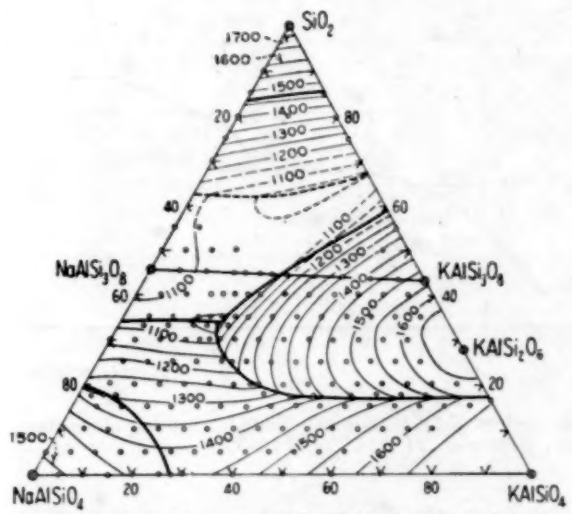

FIG. 291.—System $NaAlSiO_4$–$KAlSiO_4$–SiO_2 with isothermals. Circles indicate determined points. J. F. SCHAIRER AND N. L. BOWEN, *Trans. Amer. Geophysical Union, 16th Ann. Meeting*, pp. 325–28 (1935).

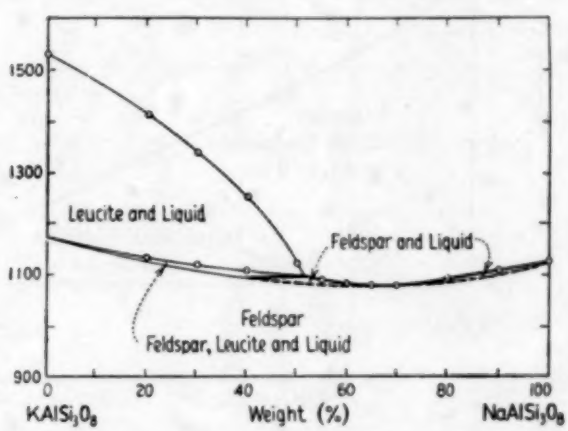

FIG. 292.—The alkali feldspar join in the system $NaAlSiO_4$–$KAlSiO_4$–SiO_2 (refer to Figs. 290 and 291). Heavy lines refer to binary equilibrium. J. F. SCHAIRER AND N. L. BOWEN, *Trans. Amer. Geophysical Union, 16th Ann. Meeting*, pp. 325–28 (1935).

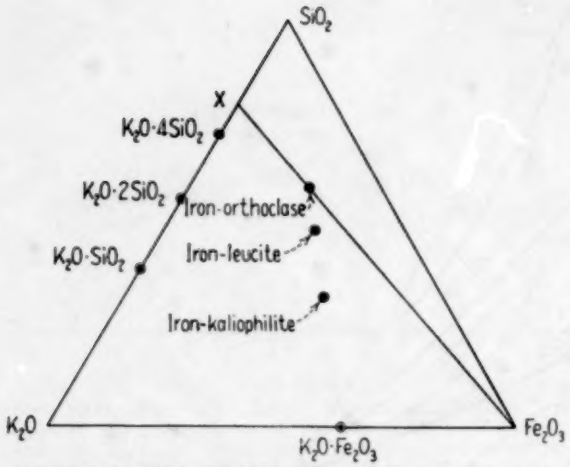

Fig. 293.—Fusion relations of iron-orthoclase (the pseudo-system $K_2O \cdot Al_2O_3 \cdot 6SiO_2$–$Fe_2O_3$). G. T. FAUST, *Amer. Mineralog.*, 21 [12] 735–63 (1936); *Ceram. Abs.*, 16 [5] 161 (1937). Section along line X–Fe_2O_3 shown in Figs. 294 and 314 (pp. 144 and 149).

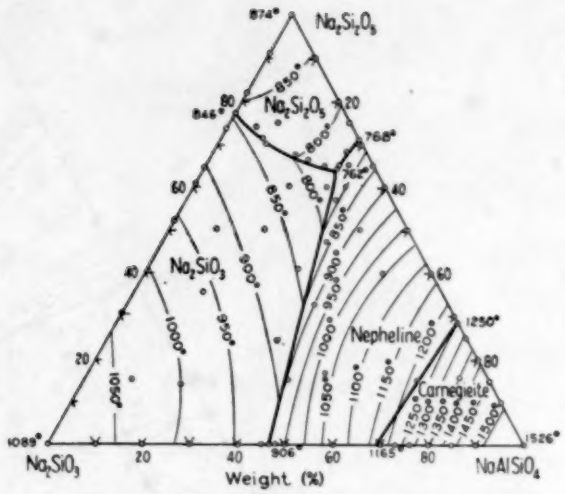

FIG. 295.—System Na_2SiO_3–$Na_2Si_2O_5$–$NaAlSiO_4$. C. E. TILLEY, *Mineralog. petrog. Mitt.*, 43, 406–21 (1933).

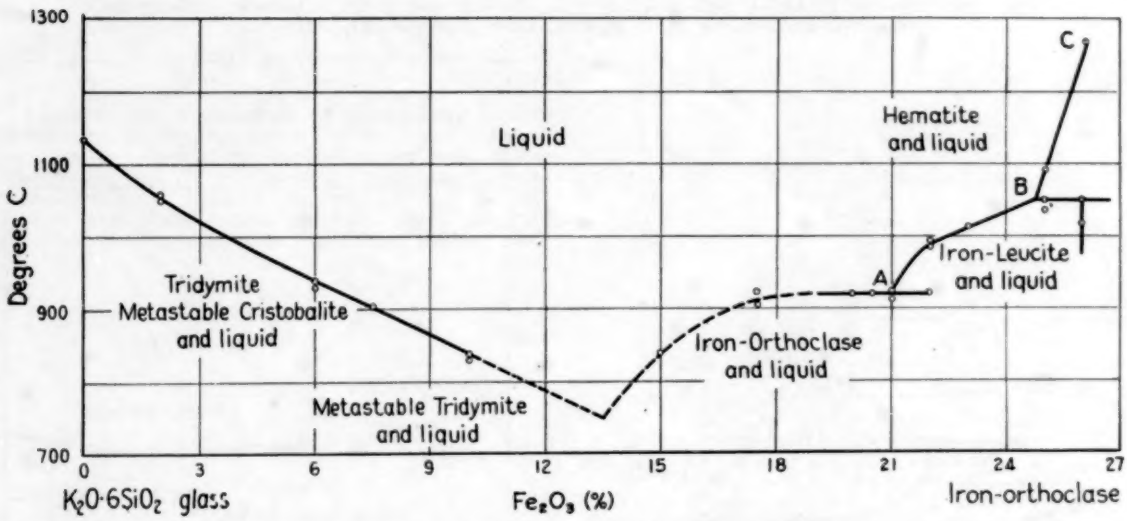

FIG. 294.—Fusion relations of iron-orthoclase (the pseudo-system $K_2O \cdot Al_2O_3 \cdot 6SiO_2$–$Fe_2O_3$). Section along line X–Fe_2O_3 of Fig. 293. G. T. FAUST, *Amer. Mineralog.*, 21 [12] 735–63 (1936).

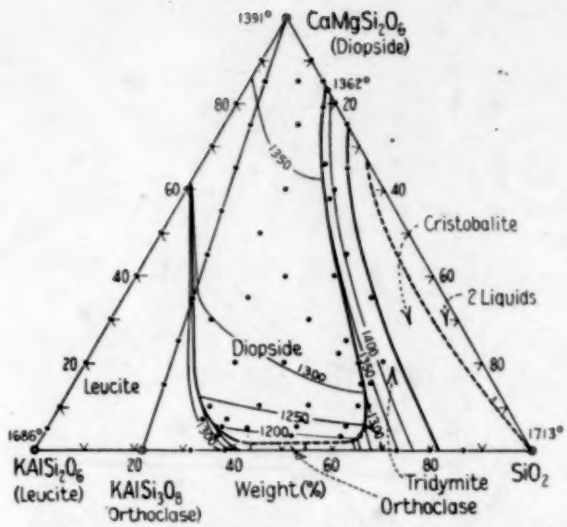

FIG. 296.—System diopside–leucite–silica ($CaMgSi_2O_6$–$KAlSi_2O_6$–SiO_2). J. F. SCHAIRER AND N. L. BOWEN, *Amer. Jour. Sci.*, **33**, 1–21 (1937).

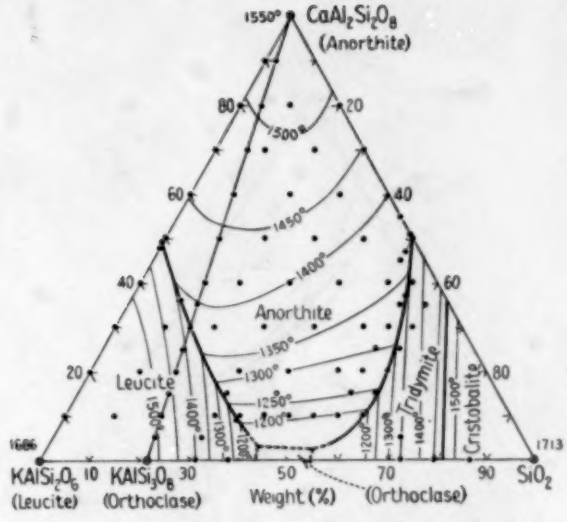

FIG. 297.—System anorthite–leucite–silica ($CaAl_2Si_2O_8$–$KAlSi_2O_6$–SiO_2). J. F. SCHAIRER AND N. L. BOWEN, *Amer. Jour. Sci.*, **33**, 1–21 (1937).

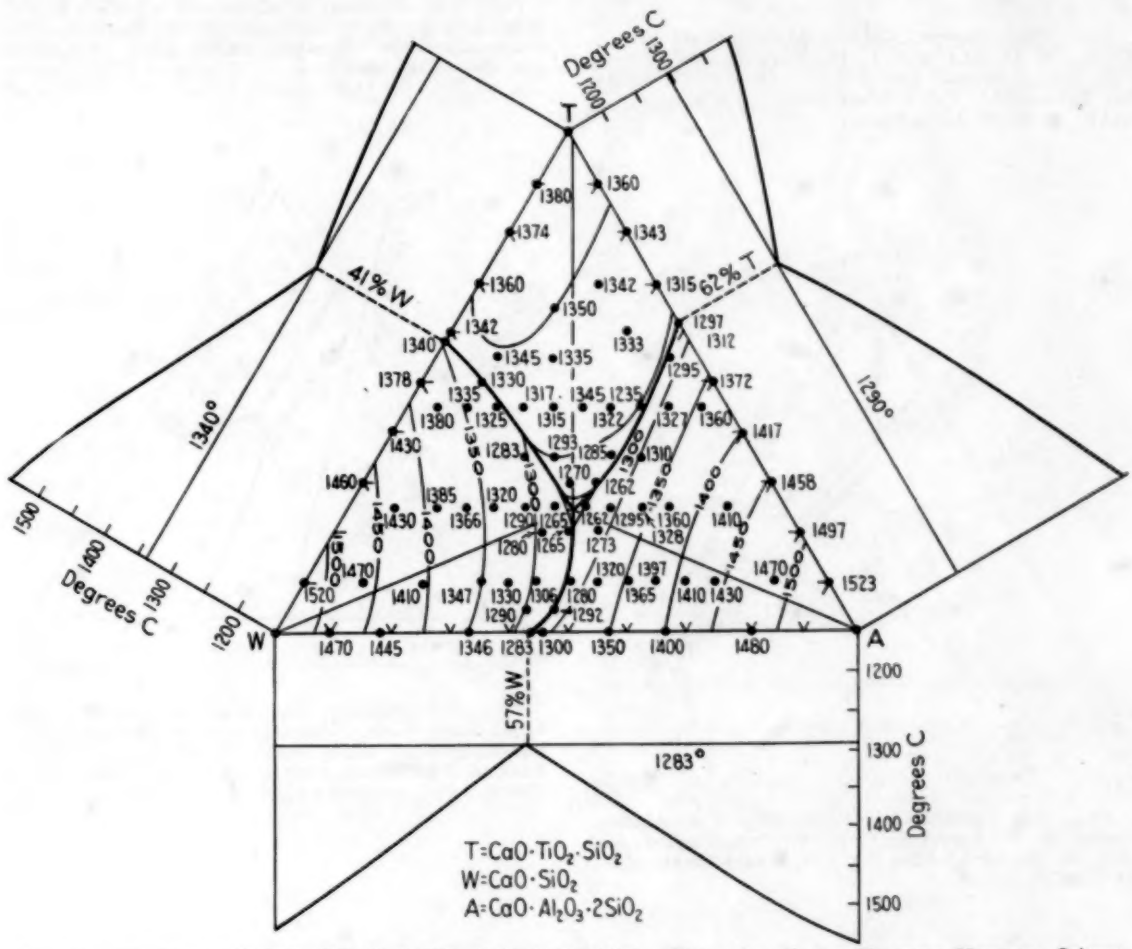

FIG. 298.—System $CaO \cdot TiO_2 \cdot SiO_2$–$CaO \cdot SiO_2$–$CaO \cdot Al_2O_3 \cdot 2SiO_2$. KEIZO IWASÉ AND USABURO NISIOKA, *Science Repts., Tôhoku Imp. Univ., Series 1, Honda Anniv. Vol.*, pp. 1–10 (1936).

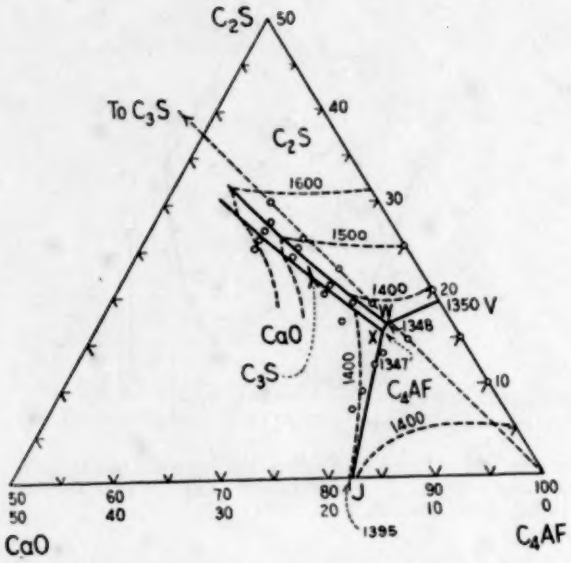

FIG. 299.—System CaO–2CaO·SiO_2–4CaO·Al_2O_3·-Fe_2O_3. F. M. LEA AND T. W. PARKER, *Phil. Trans. Roy. Soc.* [London], **234** [731] 16 (1934). (Compare Fig. 235, p. 129.) C_2S = 2CaO·SiO_2; C_3S = 3CaO·SiO_2; C_4AF = 4CaO·Al_2O_3·Fe_2O_3.

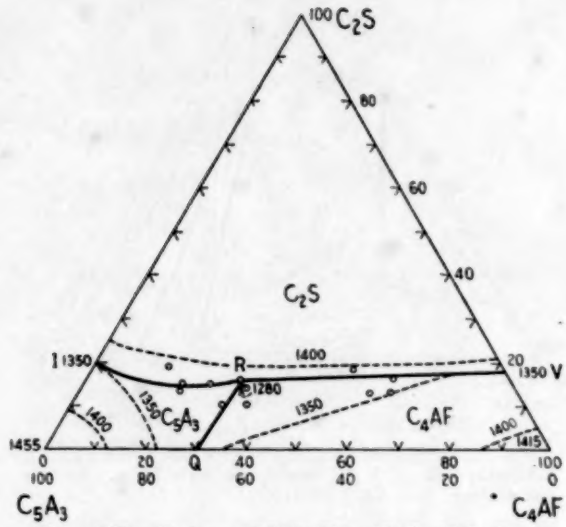

FIG. 301.—System 2CaO·SiO_2–4CaO·Al_2O_3·Fe_2O_3–5CaO·3Al_2O_3. F. M. LEA AND T. W. PARKER, *Phil. Trans. Roy. Soc.* [London], **A234** [731] 16 (1934). C_5A_3 = 5CaO·3Al_2O_3.

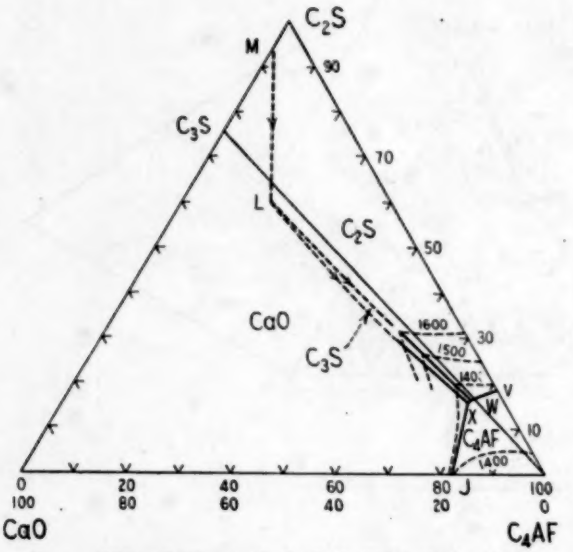

FIG. 300.—System CaO–CaO·SiO_2–4CaO·Al_2O_3·-Fe_2O_3. F. M. LEA AND T. W. PARKER, *Phil. Trans. Roy. Soc.* [London], **A234** [731] 16 (1934); *Ceram. Abs.*, **14** [7] 173 (1935).

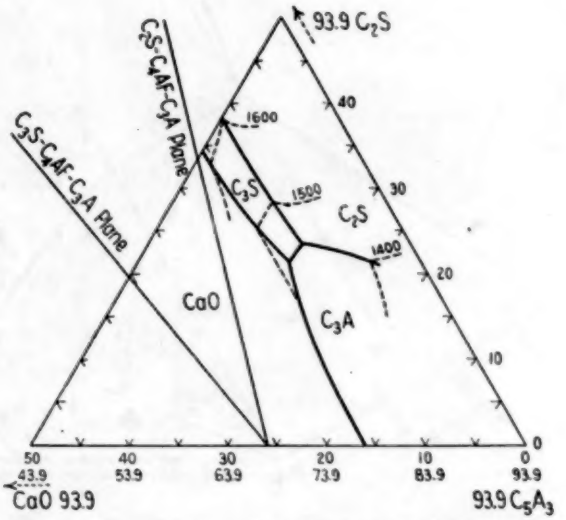

FIG. 302.—System CaO–2CaO·SiO_2–5CaO·3Al_2O_3–4CaO·Al_2O_3·Fe_2O_3. Plane through tetrahedron containing 6.1% 4CaO·Al_2O_3·Fe_2O_3. F. M. LEA AND T. W. PARKER, *Phil. Trans. Roy. Soc.* [London], **A234** [731] 16 (1934). C_3A = 3CaO·Al_2O_3.

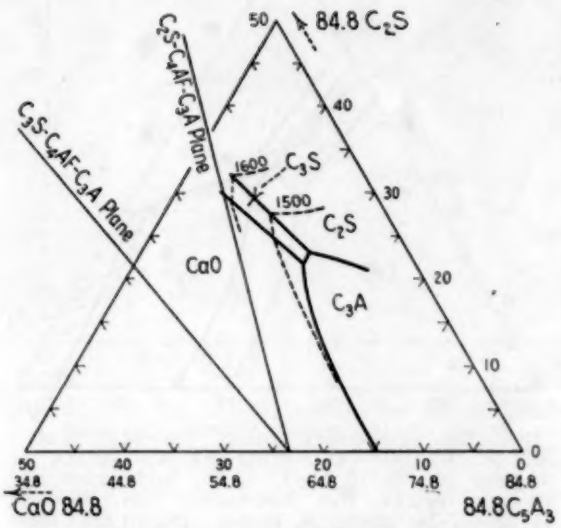

FIG. 303.—System CaO–$2CaO \cdot SiO_2$–$5CaO \cdot 3Al_2O_3$–$4CaO \cdot Al_2O_3 \cdot Fe_2O_3$. Plane through tetrahedron containing 15.2% C_4AF. F. M. LEA AND T. W. PARKER, *Phil. Trans. Roy. Soc.* [London], **A234** [731] 16 (1934).

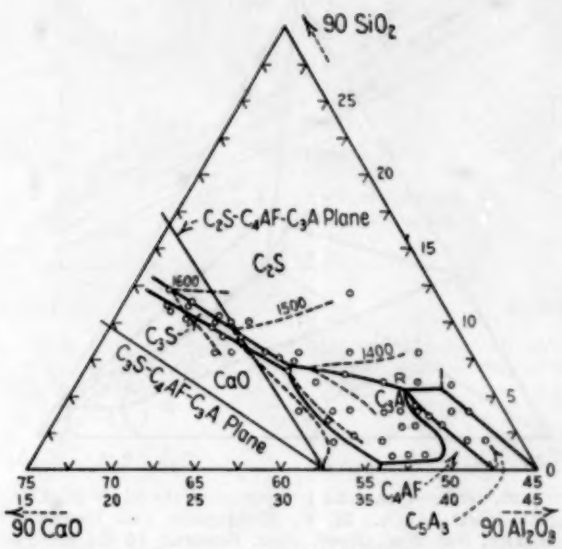

FIG. 305.—System CaO–SiO_2–Al_2O_3–Fe_2O_3. Plane through tetrahedron containing 10% Fe_2O_3. F. M. LEA AND T. W. PARKER, *Phil. Trans. Roy. Soc.* [London], **A234** [731] 16 (1934).

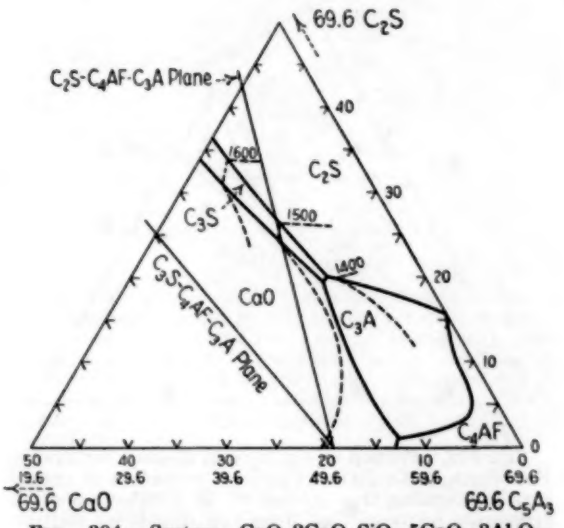

FIG. 304.—System CaO–$2CaO \cdot SiO_2$–$5CaO \cdot 3Al_2O_3$–$4CaO \cdot Al_2O_3 \cdot Fe_2O_3$. Plane through tetrahedron containing 30.4% C_4AF. F. M. LEA AND T. W. PARKER, *Phil. Trans. Roy. Soc.* [London], **A234** [731] 16 (1934).

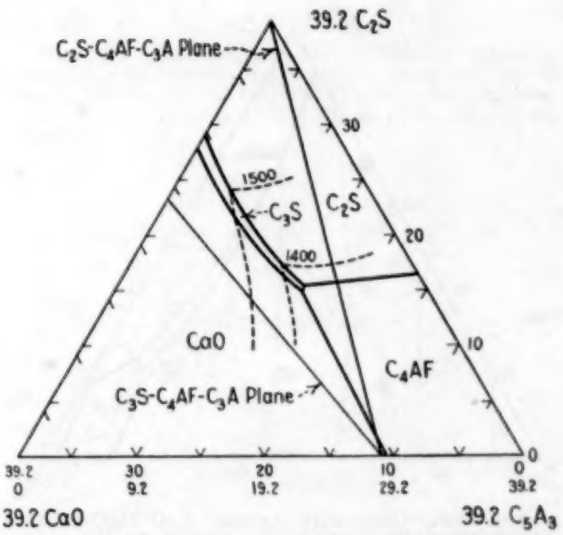

FIG. 306.—System CaO–$2CaO \cdot SiO_2$–$5CaO \cdot 3Al_2O_3$–$4CaO \cdot Al_2O_3 \cdot Fe_2O_3$. Plane through tetrahedron containing 60.8% C_4AF. F. M. LEA AND T. W. PARKER, *Phil. Trans. Roy. Soc.* [London], **A234** [731] 16 (1934); *Ceram. Abs.*, **14** [7] 173 (1935).

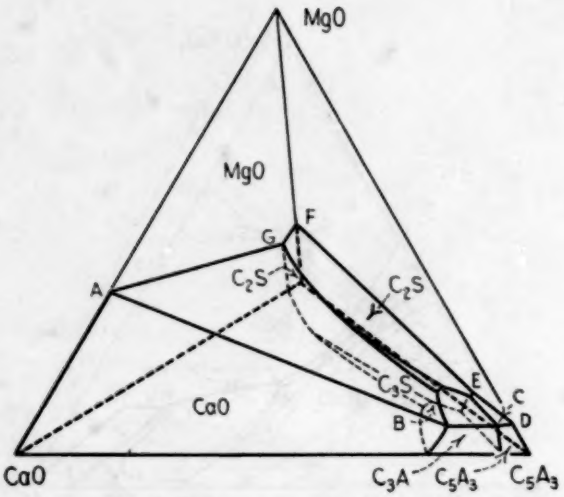

FIG. 307.—Quaternary system CaO–MgO–2CaO·SiO_2–5CaO·$3Al_2O_3$. H. F. McMURDIE AND HERBERT INSLEY, *Nat. Bur. Stand. Jour. Research*, **16** [5] 467–74 (1936); R. P. 884; *Ceram. Abs.*, **15** [8] 264 (1936). C_3S = 3CaO·SiO_2; C_2S = 2CaO·SiO_2; C_3A = 3CaO·Al_2O_3; C_5A_3 = 5CaO·$3Al_2O_3$.

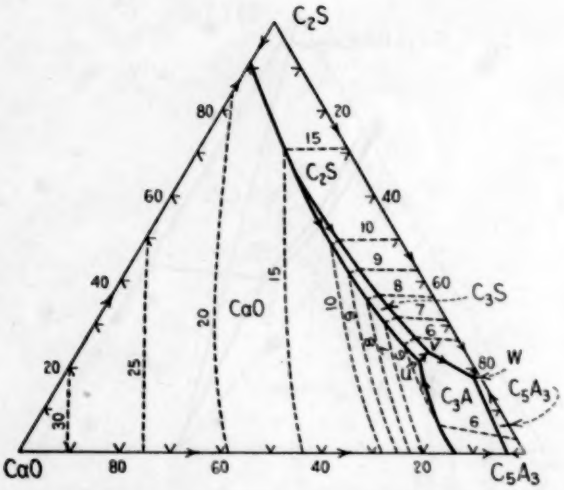

FIG. 308.—Quaternary system CaO–MgO–2CaO·SiO_2–5CaO·$3Al_2O_3$. Plane above which MgO becomes the primary phase. H. F. McMURDIE AND HERBERT INSLEY, *Nat. Bur. Stand. Jour. Research*, **16** [5] 467–74 (1936); R. P. 884. C_3S = 3CaO·SiO_2; C_2S = 2CaO·SiO_2; C_3A = 3CaO·Al_2O_3; C_5A_3 = 5CaO·$3Al_2O_3$.

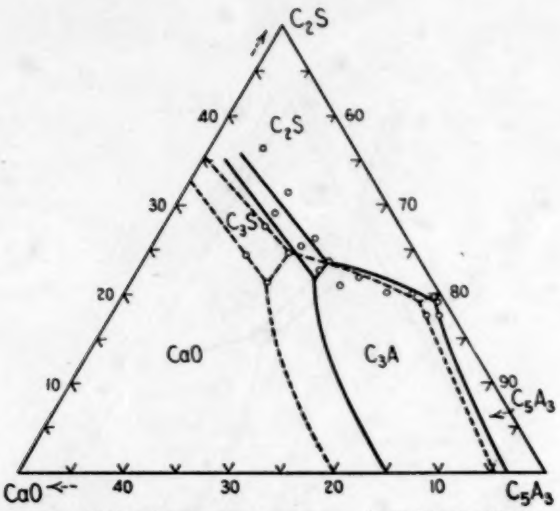

FIG. 309.—Quaternary system CaO–MgO–2CaO·SiO_2–5CaO·$3Al_2O_3$. CaO–2CaO·SiO_2–5CaO·$3Al_2O_3$ as modified by 5% of MgO. H. F. McMURDIE AND HERBERT INSLEY, *Nat. Bur. Stand. Jour. Research*, **16** [5] 467–74 (1936); R. P. 884. Dotted lines show original boundary curves from G. A. RANKIN AND F. E. WRIGHT, *Amer. Jour. Sci.*, **39** [4] 1–52 (1915); full lines show boundaries with 5% MgO added.

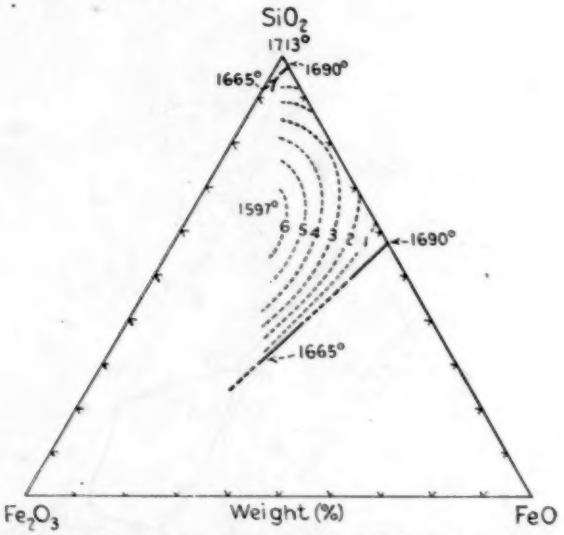

FIG. 310.—Portion of equilibrium diagram for system FeO–Fe_2O_3–Al_2O_3–SiO_2. This is a projection of curved surface bounding that portion of the tetrahedron which represents mixtures that form two liquids on melting. That apex of the tetrahedron which corresponds to pure Al_2O_3 is the pole of projection; the projection is on the opposite face. The dotted lines are projections of intersections of above surface with planes corresponding to 1%, 2%, 3%, etc., Al_2O_3; numbers indicate percentage of Al_2O_3. Projections of isothermal surfaces are not shown, but temperatures of equilibrium of cristobalite with liquid are indicated by numbers for several compositions on curved bounding surface. J. W. GREIG, *Amer. Jour. Sci.*, **14**, 474 (1927); *Ceram. Abs.*, **7** [2] 104 (1928).

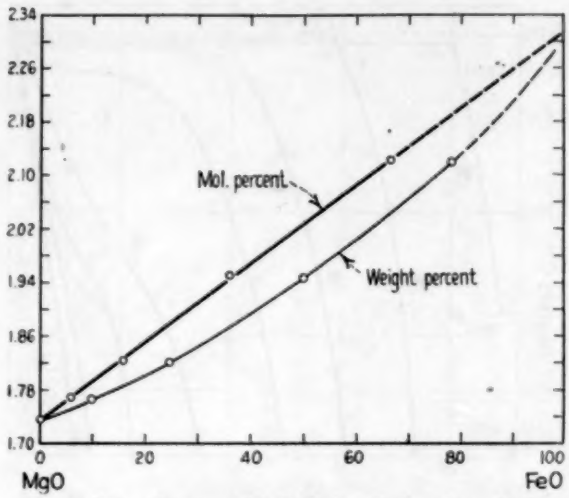

FIG. 311.—System MgO–FeO. Refractive indices (Na light) of magnesio-wüstites. N. L. BOWEN AND J. F. SCHAIRER, *Amer. Jour. Sci.*, **29**, 151–217 (1935); *Ceram. Abs.*, **15** [9] 288 (1936). Refer to Fig. 186 (p. 117) for general character of equilibrium diagram of system MgO–FeO.

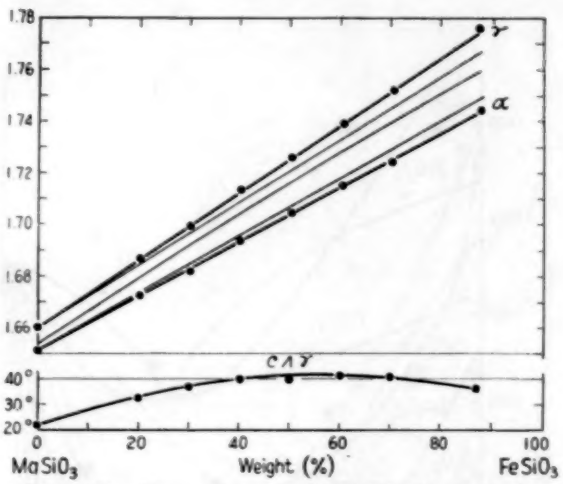

FIG. 312.—*Heavy curves:* refractive indices, γ and α, and extinction angles of monoclinic Mg·Fe pyroxenes. The curve for β is omitted because it lies very close to and nearly parallel to the curve for α. *Light curves:* most probable values of the refractive indices γ', β', and α of the orthorhombic Mg–Fe pyroxenes. N. L. BOWEN AND J. F. SCHAIRER, *Amer. Jour. Sci.*, **29**, 198 (1935).

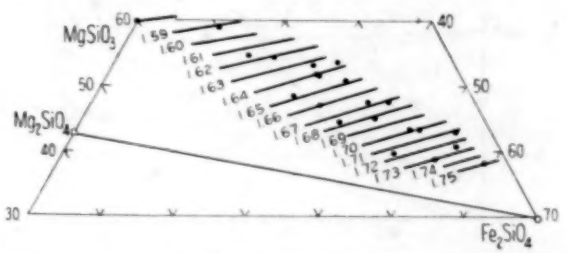

FIG. 315.—Refractive indices of glasses in system MgO–FeO–SiO$_2$. N. L. BOWEN AND J. F. SCHAIRER, *Amer. Jour. Sci.*, **29**, 200 (1935).

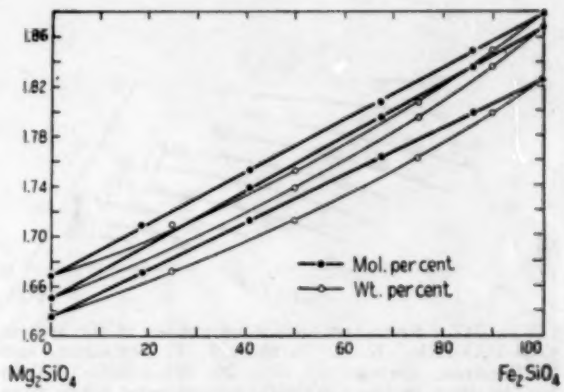

FIG. 313.—Refractive indices of Mg–Fe olivines. N. L. BOWEN AND J. F. SCHAIRER, *Amer. Jour. Sci.*, **29**, 197 (1935).

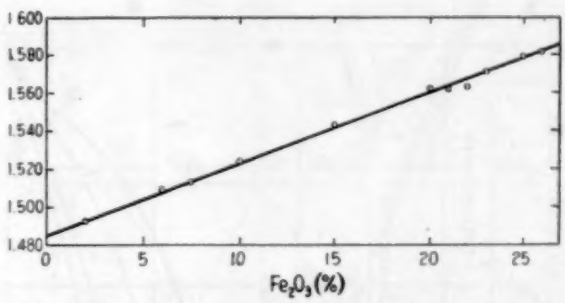

FIG. 314.—Relation between the index of refraction and the iron content of the glasses along the line *X*-Fe$_2$O$_3$. See Fig. 294 (p. 144), G.T. FAUST, *Amer. Mineralogist*, **21** [12] 735–63 (1936); *Ceram. Abs.*, **16** [5] 161 (1937).

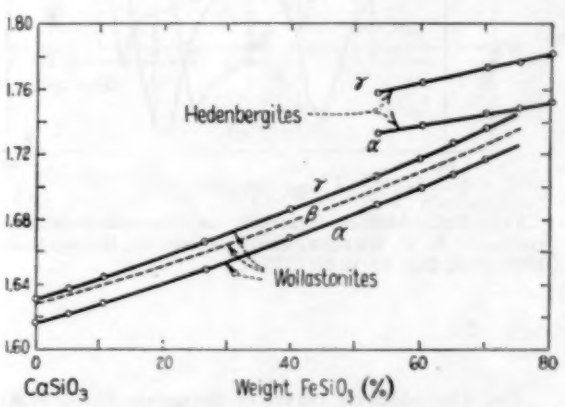

FIG. 316.—Optical properties of wollastonite solid solutions and hedenbergite solid solutions in the system CaO–FeO–SiO$_2$. N. L. BOWEN, J. F. SCHAIRER, AND E. POSNJAK, *Amer. Jour. Sci.*, **26**, 258 (1933).

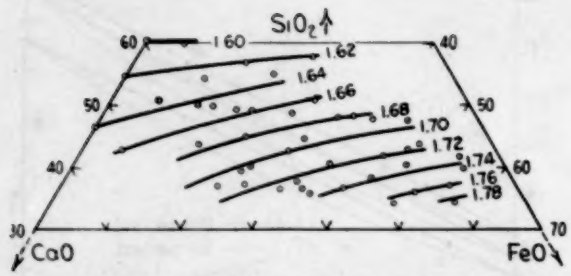

FIG. 317.—Refractive indices of glasses in the system $CaO–FeO–SiO_2$. N. L. BOWEN, J. F. SCHAIRER, AND E. POSNJAK, *Amer. Jour. Sci.*, **26**, 264 (1933). Values for the glass in the $CaO–SiO_2$ system were taken from G. W. MOREY AND H. E. MERWIN, *Jour. Opt. Soc. Amer.*, **22**, 632–62 (1932); *Ceram. Abs.*, **12** [6] 218 (1933).

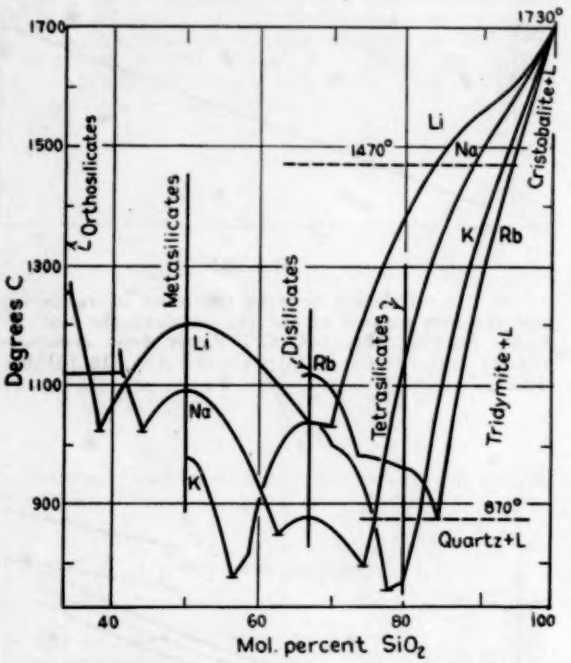

FIG. 318.—Melting relations in the alkali–silicate systems. F. C. KRACEK, *Carnegie Inst. of Washington, Year Book*, No. 32, p. 63 (1933).

FIG. 320.—Melting curves of BeO with ThO_2, MgO, ZrO_2, CeO_2, CoO, Cr_2O_3, La_2O_3, Al_2O_3, NiO, CaO, Fe_3O_4, Mn_3O_4, and Cu_2O. H. v. WARTENBERG, H. J. REUSCH, AND E. SARAN, *Z. anorg. allgem. Chem.*, **230**, 267 (1937); *Ceram. Abs.*, **16** [10] 313 (1937).

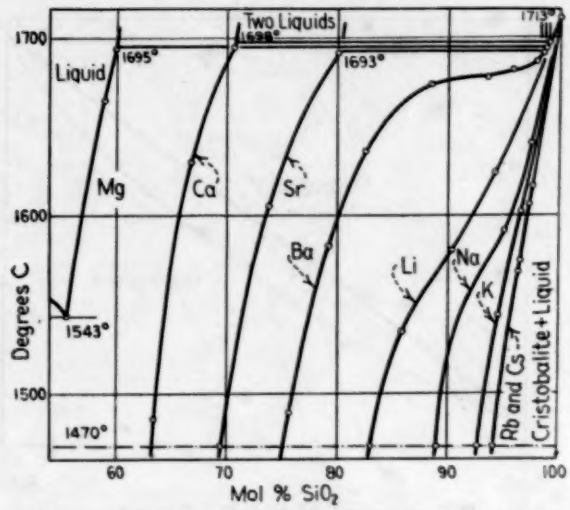

FIG. 319.—Liquidus relations for cristobalite in the alkali and alkali earth–silicate systems. F. C. KRACEK, *Ann. Rept. of Director of Geophysical Laboratory, Year Book*, No. 32, p. 61 (1932–33); Carnegie Inst. of Washington.

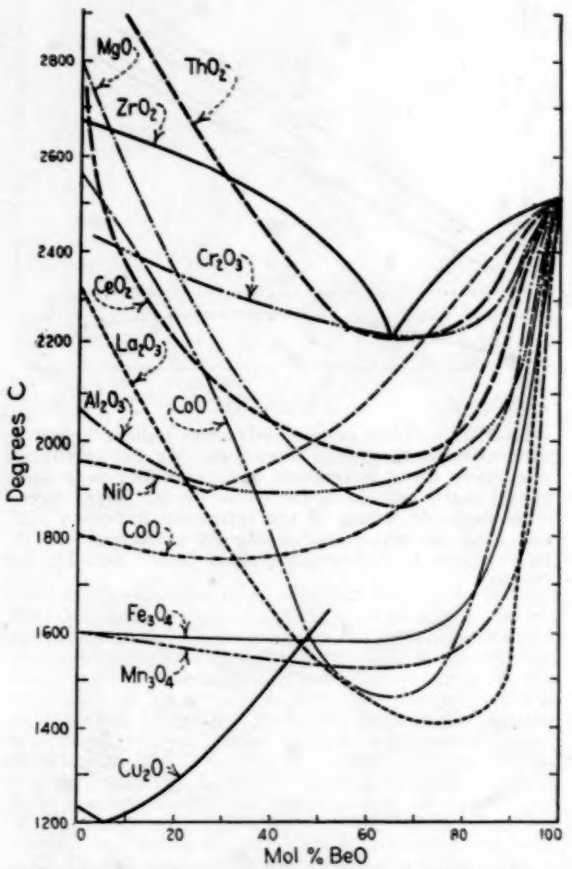

FIG. 320.—NOTE: The curve lying between NiO and Fe_3O_4 should read CaO (see also legend in left column).

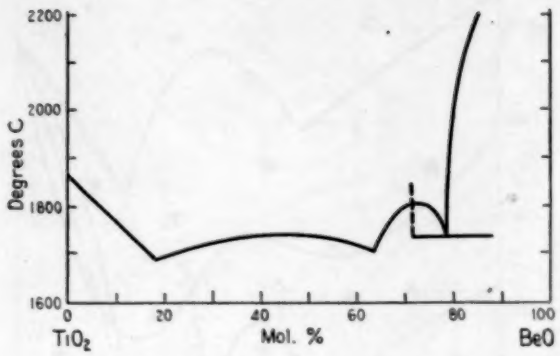

FIG. 321.—Melting curve TiO_2–BeO. H. v. WARTENBERG, H. J. REUSCH, AND E. SARAN, *Z. anorg. allgem. Chem.*, **230**, 267 (1937).

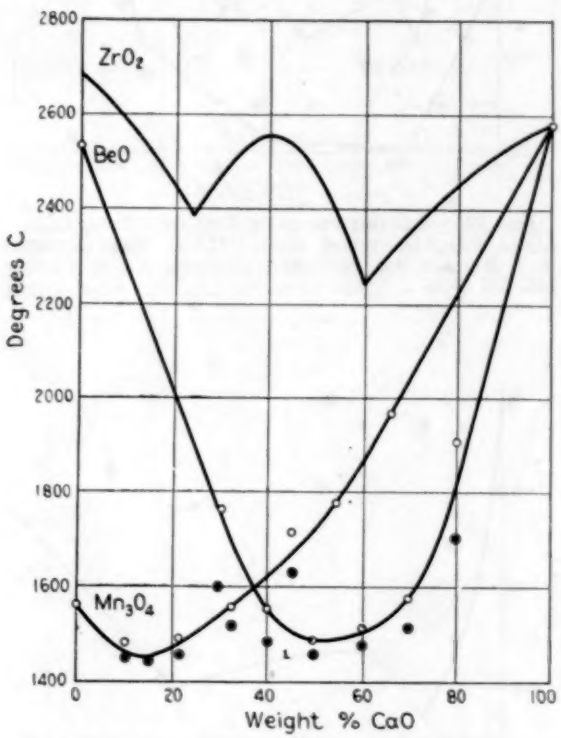

FIG. 322.—Melting diagram of CaO with ZrO_2, BeO, and Mn_3O_4. H. J. REUSCH AND H. v. WARTENBERG, *Heraeus-Vacuumschmelze Anniv. Vol., Hanau*, p. 353, 1933.

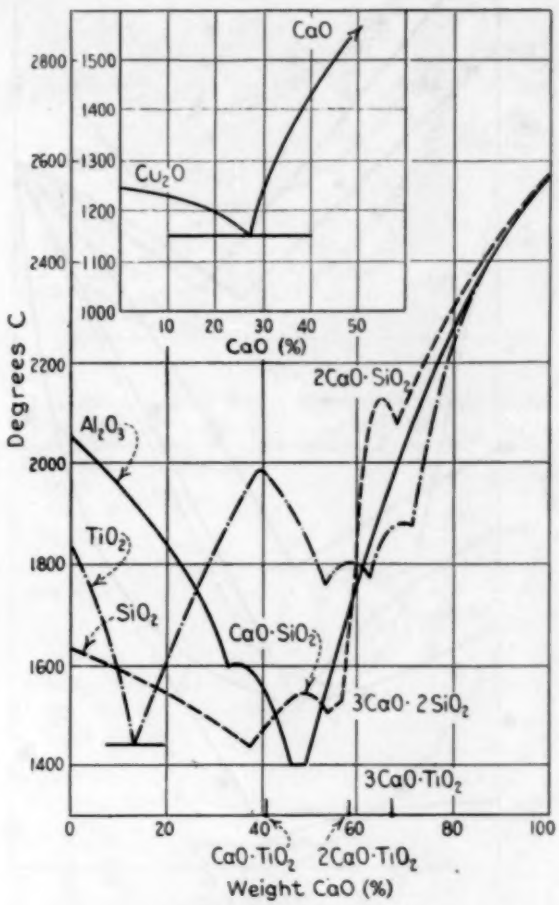

FIG. 323.—Melting diagram of CaO with Cu_2O, Al_2O_3, TiO_2, and SiO_2. H. J. REUSCH AND H. v. WARTENBERG, *Heraeus-Vacuumschmelze Anniv. Vol., Hanau*, p. 350, 1933; *Ceram. Abs.*, **13** [10] 263 (1934).

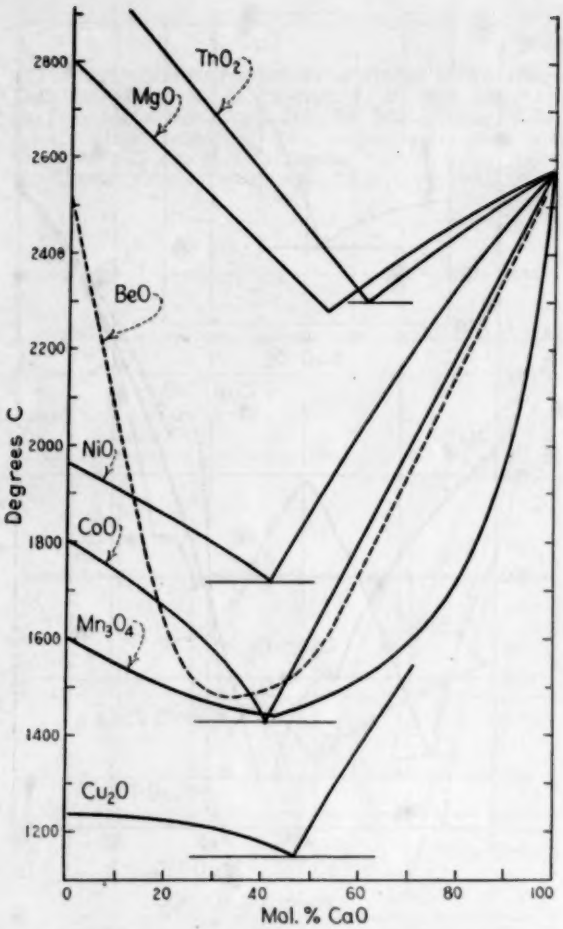

FIG. 324.—Melting curves of CaO with ThO_2, MgO, BeO, NiO, CoO, Mn_3O_4, and Cu_2O. H. v. WARTENBERG, H. J. REUSCH, AND E. SARAN, *Z. anorg. allgem. Chem.*, **230**, 267 (1937); *Ceram. Abs.*, **16** [10] 313 (1937).

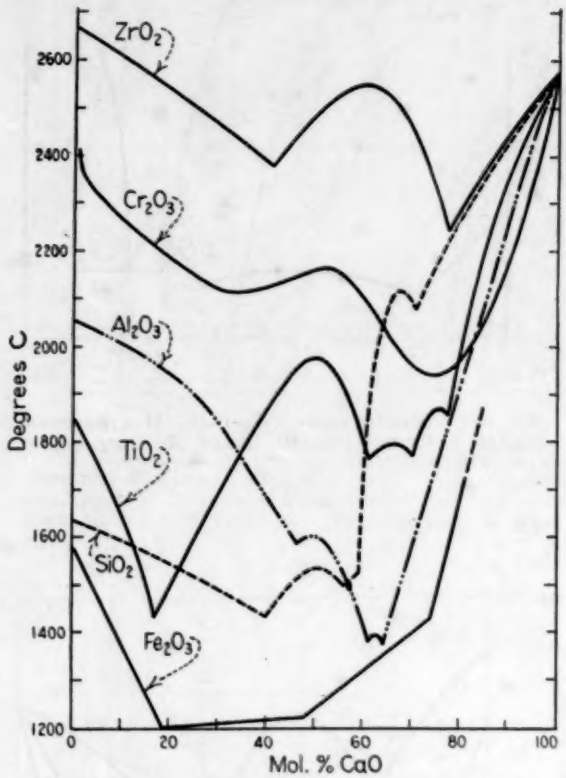

FIG. 325.—Melting curves of CaO with ZrO_2, Cr_2O_3, Al_2O_3, TiO_2, SiO_2, and Fe_2O_3. H. v. WARTENBERG, H. J. REUSCH, AND E. SARAN, *Z. anorg. allgem. Chem.*, **230**, 257 (1937).

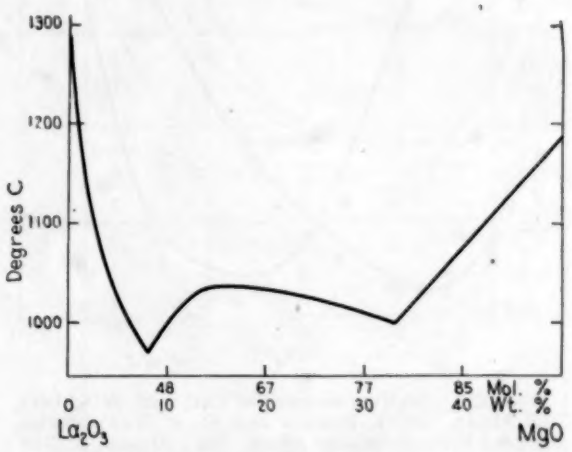

FIG. 327.—Melting curve La_2O_3–MgO. H. v. WARTENBERG AND K. ECKHARDT, *Z. anorg. allgem. Chem.*, **232**, 179 (1937).

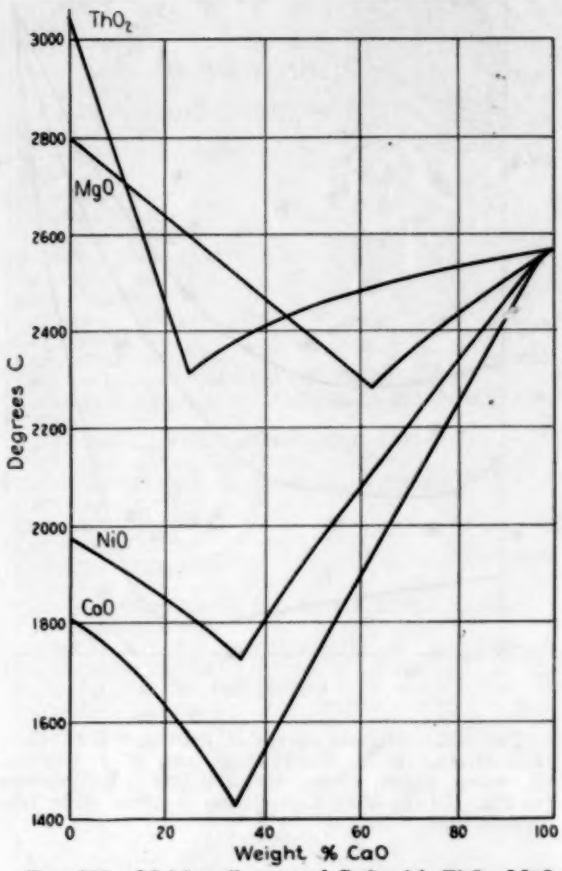

FIG. 326.—Melting diagram of CaO with ThO_2, MgO, NiO, and CoO. H. J. REUSCH AND H. V. WARTENBERG, *Heraeus-Vacuumschmelze Anniv. Vol., Hanau*, p 352, 1933; *Ceram. Abs.*, **13** [10] 263 (1934).

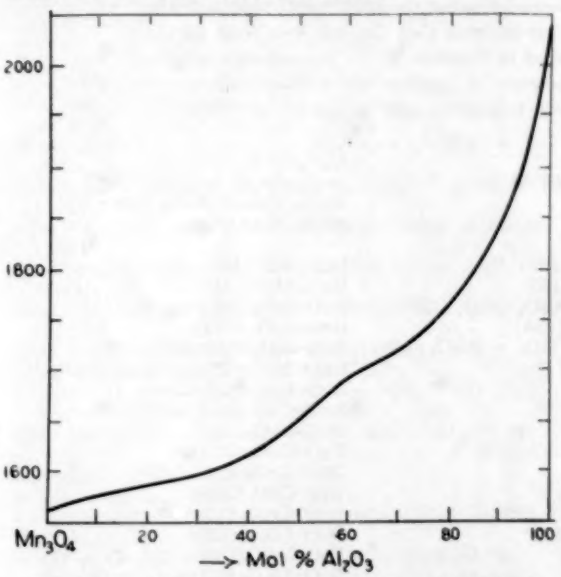

FIG. 328.—Melting curves of Al_2O_3 with Mn_3O_4. H. V. WARTENBERG AND H. J. REUSCH, *Z. anorg. allgem. Chem.*, **208**, 381 (1932). Correction to Fig. *171*, Compilation of Phase Rule Diagrams, 1933.

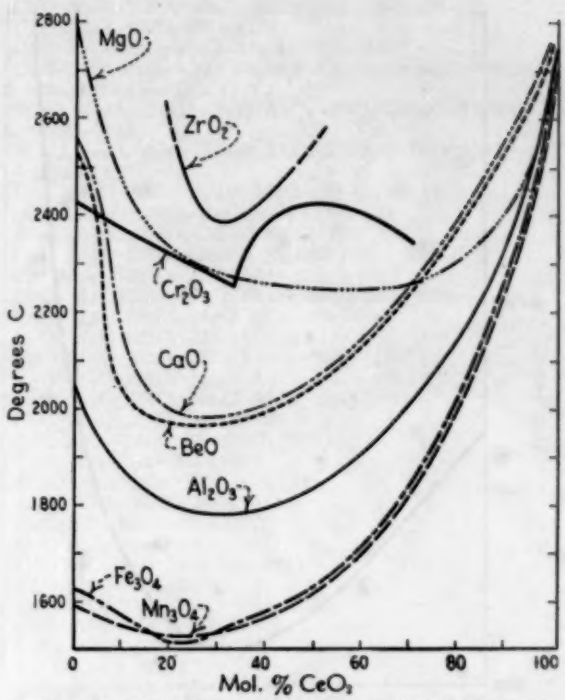

FIG. 329.—Melting curves of CeO_2 with ZrO_2, MgO, Cr_2O_3, CaO, BeO, Al_2O_3, Fe_3O_4, and Mn_3O_4. H. V. WARTENBERG AND K. ECKHARDT, *Z. anorg. allgem. Chem.*, **232**, 179 (1937).

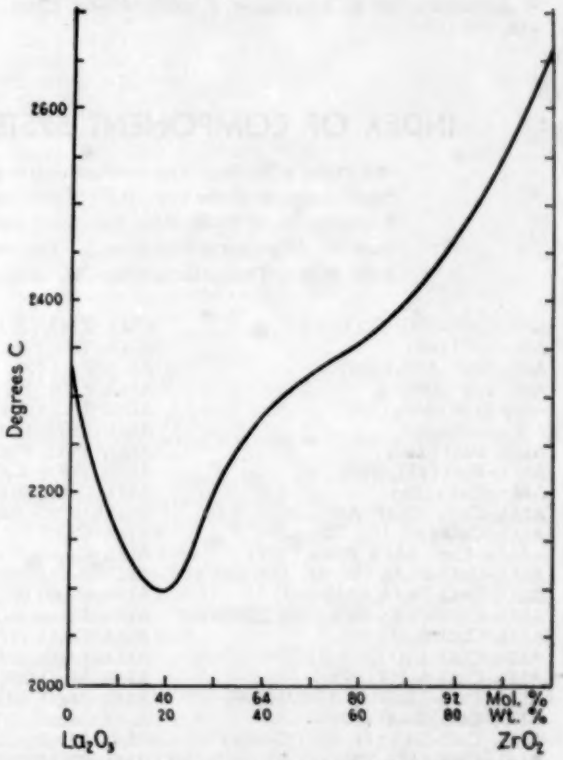

FIG. 330.—Melting curve ZrO_2–La_2O_3. H. V. WARTENBERG AND K. ECKHARDT, *Z. anorg. allgem. Chem.*, **232**, 179 (1937).

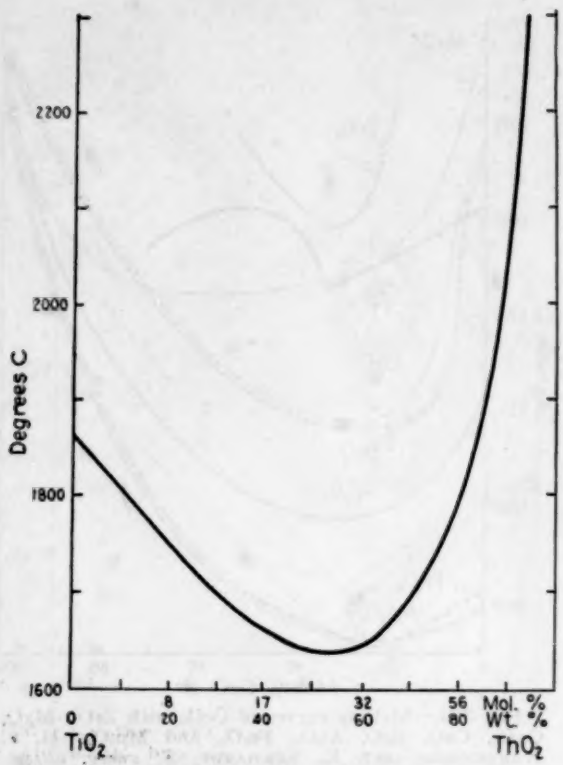

FIG. 331.—Melting curve TiO_2 and ThO_2. H. v. WARTENBERG AND K. ECKHARDT, *Z. anorg. allgem. Chem.*, **232**, 179 (1937).

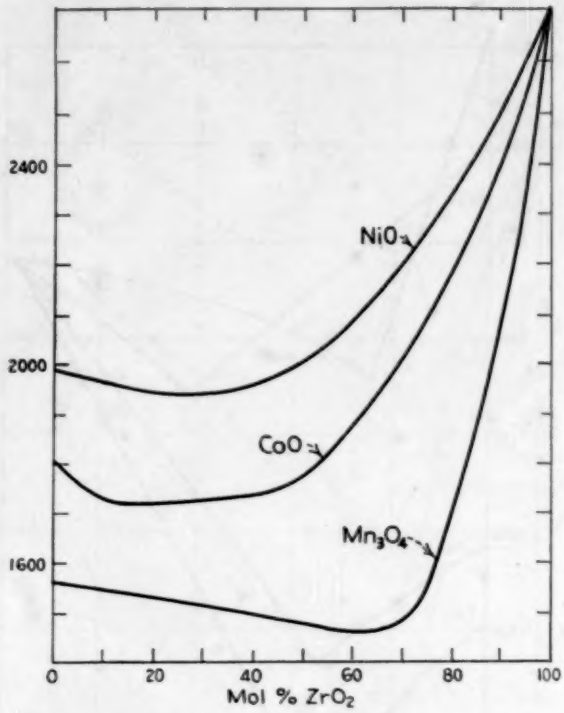

FIG. 332.—Melting curves of ZrO_2 and NiO, CoO, and Mn_3O_4. H. v. WARTENBERG AND H. J. REUSCH, *Z. anorg. allgem. Chem.*, **208**, 380 (1932). Correction to Fig. *174* (p. 563), Compilation of Phase Rule Diagrams, 1933.

INDEX OF COMPONENT SYSTEMS OF PHASE-RULE DIAGRAMS

EDITOR'S NOTE: The number in parentheses following the component system is the figure number of the cut; *italic figure numbers* indicate that the cut was used in the Compilation of Phase-Rule Diagrams published in October, 1933; Roman figures indicate the diagrams in this issue. The components of systems are arranged alphabetically only. Thus, the system $CaO–Al_2O_3–SiO_2$ is indexed only as $Al_2O_3–CaO–SiO_2$.

$AlF_3–CaF_2–NaF$ (*71*)
$AlF_3–KF$ (188)
$AlF_3–3KF·AlF_3$ (189)
$AlF_3–LiF$ (190)
$AlF_3–3LiF·AlF_3$ (191)
$AlF_3–NaF$ (*25*)
$Al_2O_3–BaO$ (*170*)
$Al_2O_3–BeO$ (*171*, 320)
$Al_2O_3–CaF_2$ (*26*)
$Al_2O_3–CaF_2–3NaF·AlF_3$ (*98*)
$Al_2O_3–CaO$ (*27*, *170*, 323, 325)
$\alpha Al_2O_3–CaO·Al_2O_3·2SiO_2$ (*127*)
$Al_2O_3–CaO–Fe_2O_3$ (*90–91*, *123–126*, *146*)
$Al_2O_3–CaO–Fe_2O_3$ (245–247)
$Al_2O_3–CaO–Fe_2O_3–SiO_2$ (235, 299–306)
$Al_2O_3–CaO–K_2O$ (*73*)
$Al_2O_3–CaO–K_2O$ (239, 240)
$Al_2O_3–CaO–MgO$ (*85*)
$Al_2O_3–CaO–MgO–SiO_2$ (307–309)
$Al_2O_3–CaO–Na_2O$ (*74*)
$Al_2O_3–CaO–SiO_2$ (*11*, *92*, *127–134*)
$Al_2O_3–CeO_2$ (*171*, 329)
$Al_2O_3–CoO$ (*170*)
$Al_2O_3–SrO$ (*170*)
$Al_2O_3–ThO_2$ (*171*)
$Al_2O_3–TiO_2$ (*46*, *170*)
$Al_2O_3–ZnO$ (*30*)
$Al_2O_3–ZrO_2$ (*171*)
$Al_2O_3–ZrO_2$ (*174*)
$Al_2O_3·2SiO_2–CaO$ (*157*)
$Al_2O_3·2SiO_2–FeO$ (*159*)
$Al_2O_3·2SiO_2–K_2O·Al_2O_3·6SiO_2$ (*160*)
$Al_2O_3·2SiO_2–MgO$ (*158*)
$3Al_2O_3·2SiO_2$ with $TiO_2 + Fe_2O_3$ (*135*)
$Al_2O_3–Cr_2O_3$ (*31*, *171*)
$Al_2O_3–Cu_2O$ (*171*)
$Al_2O_3–FeO$ (192)
$Al_2O_3–Fe_3O_4$ (*171*)
$Al_2O_3–FeO–Fe_2O_3–SiO_2$ (310)
$Al_2O_3–Ga_2O_3$ (*171*)
$Al_2O_3–La_2O_3$ (*171*)
$Al_2O_3–MgO$ (*29*, *168*, *170*)
$Al_2O_3–MgO–SiO_2$ (*94*)
$Al_2O_3–Mn_3O_4$ (*171*)
$Al_2O_3–Mn_3O_4$ (328)
$Al_2O_3–3NaF·AlF_3$ (*51*, *52*)
$Al_2O_3–NiO$ (*170*)
$Al_2O_3–SiO_2$ (*45*, *170*)
$Al_2O_3–SiO_2–ZnO$ (*95*)
$As_2O_5–3K_2O·As_2O_5$ (208)
$As_2O_5–3Na_2O·As_2O_5$ (209)
$As_2O_5–PbO$ (204)

$BaF_2–KF$ (187)
$BaO–MgO$ (*169*)
$BaO–SiO_2$ (*36*, *140*, 319)
$BaO–ZrO_2$ (*172*)
$BaO·SiO_2–CaO·SiO_2$ (*59*)
$BaO·2SiO_2–2BaO·3SiO_2$ (*140*)
$BeO–CaO$ (322, 324)
$BeO–CaO–ZrO_2$ (*175*)
$BeO–CeO_2$ (320)
$BeO–CeO_2$ (329)
$BeO–CeO_2–ZrO_2$ (*176*)
$BeO–CoO$ (320)
$BeO–Cr_2O_3$ (320)
$BeO–Cu_2O$ (320)
$BeO–Fe_3O_4$ (320)
$BeO–La_2O_3$ (320)
$BeO–MgO$ (*169*, 320)
$BeO–Mn_3O_4$ (320)
$BeO–NiO$ (320)

BeO–ThO_2 (320)
BeO–TiO_2 (321)
BeO–ZrO_2 (*173*)
Bi_2O_3·3MoO_3–PbO·MoO_3 (231)
Bi_2O_3–PbO (199)
Bi_2O_3·3WO_3–PbO·WO_3 (232)
B_2O_3–CaO (*28*)
B_2O_3–CaO–SiO_2 (281–287)
B_2O_3–CdO (195)
B_2O_3–Li_2O (193)
B_2O_3–MnO (196)
B_2O_3–Na_2O (194)
B_2O_3–Na_2O·B_2O_3 (194)
B_2O_3–PbO (197, 198)
CaF_2–CaO·SiO_2 (207)
CaF_2–MgF_2 (184)
CaF_2–NaF (180)
CaF_2–3NaF·AlF_3 (*50*)
CaO–CaO·Al_2O_3–4CaO·Al_2O_3·Fe_2O_3 (245–247)
CaO–5CaO·3Al_2O_3–4CaO·Al_2O_3·Fe_2O_3–2CaO·SiO_2 (302–306)
CaO–5CaO·3Al_2O_3–2CaO·SiO_2–MgO (307–309)
CaO–4CaO·Al_2O_3·Fe_2O_3 (*123*)
CaO–4CaO·Al_2O_3·Fe_2O_3–2CaO·SiO_2 (299–300)
CaO–Ce_2O_4 (329)
CaO–CoO (324, 326)
CaO–Cr_2O_3 (325)
CaO–Cu_2O (323, 324)
CaO–Fe_2O_3 (325)
CaO–FeO–SiO_2 (248–54, 256–66, 316, 319)
CaO–Fe_2O_3–SiO_2 (*93*)
CaO–K_2O–SiO_2 (*75–76, 103–106*)
CaO–K_2O·Al_2O_3·6SiO_2 (*162*)
CaO–MgO (*24, 169*, 324, 326)
CaO–MgO–SiO_2 (*88–89, 116–122*)
CaO–Mn_3O_4 (322, 324)
CaO–Na_2O–SiO_2 (*77–78, 107–108*)
CaO–Na_2O·Al_2O_3·6SiO_2 (*165*)
CaO–NiO (324, 326)
CaO–SiO_2 (*37*, 265, 323, 325)
CaO·SiO_2–TiO_2 (216)
CaO–ThO_2 (324, 326)
CaO–ThO_2–ZrO_2 (*177*)
CaO–TiO_2 (323, 325)
CaO·TiO_2–SiO_2 (217)
CaO–ZrO_2 (*44, 172*, 322, 325)
5CaO·3Al_2O_3–4CaO·Al_2O_3·Fe_2O_3 (*126*)
5CaO·3Al_2O_3–4CaO·Al_2O_3·Fe_2O_3–2CaO·SiO_2 (301)
3CaO·5Al_2O_3–2CaO·Al_2O_3·SiO_2 (*131*)
CaO·Al_2O_3–CaO·SiO_2 (*129*)
5CaO·3Al_2O_3–2CaO·SiO_2 (*130*)
4CaO·Al_2O_3·Fe_2O_3–2CaO·SiO_2 (235)
CaO·Al_2O_3·2SiO_2–2CaO·Al_2O_3·SiO_2 (*134*)
2CaO·Al_2O_3·SiO_2–3CaO·Al_2O_3·3SiO_2–2CaO·MgO·2SiO_2 (*102, 148*)
3CaO·Al_2O_3·3SiO_2–3CaO·Fe_2O_3·3SiO_2–3FeO·Al_2O_3·3SiO_2 (*151*)
3CaO·Al_2O_3·3SiO_2–3CaO·Fe_2O_3·3SiO_2–3MgO·Al_2O_3·3SiO (*155*)
3CaO·Al_2O_3·3SiO_2–3CaO·Fe_2O_3·3SiO_2–3MnO·Al_2O_3·3SiO_2 (*153*)
3CaO·Al_2O_3·3SiO_2–3FeO·Al_2O_3·3SiO_2–3MnO·Al_2O_3·3SiO_2 (*152*)
CaO·Al_2O_3·2SiO_2–CaO·MgO·2SiO_2 (*69*)
2CaO·Al_2O_3·SiO_2–2CaO·MgO·2SiO_2 (*70, 147*)
2CaO·Al_2O_3·SiO_2–2CaO·MgO·2SiO_2–90%[3CaO·Al_2O_3·3SiO_2]10%[3Na_2O·Al_2O_3·3SiO_2] (*101, 139*)
CaO·Al_2O_3·2SiO_2–CaO·MgO·2SiO_2–Na_2O·Al_2O_3·6SiO_2 (*100*)
CaO·Al_2O_3·2SiO_2–CaO·SiO_2 (*133*)
2CaO·Al_2O_3·SiO_2–2CaO·SiO_2 (*132*)
CaO·Al_2O_3·2SiO_2–CaO·SiO_2–CaO·SiO_2·TiO_2 (298)
CaO·Al_2O_3·2SiO_2–CaO·TiO_2 (236)
3CaO·Al_2O_3·3SiO_2–3FeO·Al_2O_3·3SiO_2–3MgO·Al_2O_3·3SiO_2 (*150*)
CaO·Al_2O_3·2SiO_2–K_2O·Al_2O_3·4SiO_2–SiO_2 (297)
CaO·Al_2O_3·2SiO_2–2MgO·SiO_2–SiO_2 (*99*)
CaO·Al_2O_3·2SiO_2–Na_2O·Al_2O_3·2SiO_2 (*67*)
CaO·Al_2O_3·2SiO_2–Na_2O·Al_2O_3·6SiO_2 (*68, 136*)
CaO·Al_2O_3·2SiO_2–SiO_2 (*128*)
CaO·FeO·2SiO_2–CaO·MgO·2SiO_2 (*145*)
CaO·FeO·2SiO_2–CaO·MgO·2SiO_2–Na_2O·Al_2O_3·4SiO_2–Na_2O·Fe_2O_3·4SiO_2 (*137*)
3CaO·Fe_2O_3·3SiO_2–3FeO·Al_2O_3·3SiO_2–3MgO·Al_2O_3·3SiO_2 (*149*)
3CaO·Fe_2O_3·3SiO_2–3FeO·Al_2O_3·3SiO_2–3MnO·Al_2O_3·3SiO_2 (*156*)
CaO·MgO·2SiO_2–2CaO·MgO·2SiO_2 (*121*)
2CaO·MgO·2SiO_2–CaO·SiO_2 (*119*)
2CaO·MgO·2SiO_2–2CaO·SiO_2 (*120*)
CaO·MgO·2SiO_2–CaO·TiO_2 (237)
CaO·MgO·2SiO_2–K_2O·Al_2O_3·4SiO_2 (*64*)
CaO·MgO·2SiO_2–K_2O·Al_2O_3·4SiO_2–SiO_2 (296)
CaO·MgO·2SiO_2–MgO·SiO_2 (*144*)
CaO·MgO·2SiO_2–2MgO·SiO_2 (*118*)
CaO·MgO·2SiO_2–2MgO·SiO_2–SiO_2 (*122*)
CaO·MgO·2SiO_2–Na_2O·Al_2O_3·2SiO_2 (*65*)
CaO·MgO·2SiO_2–Na_2O·Al_2O_3·6SiO_2 (*66*)
CaO·MgO·2SiO_2–SiO_2 (*116*)
CaO·SiO_2–CaO·FeO·2SiO_2 (316)
CaO·SiO_2–CaO·TiO_2 (*61*)
2CaO·SiO_2–2FeO·SiO_2 (*58, 142*)
2CaO·SiO_2–2Li_2O·SiO_2 (*57*)
CaO·SiO_2–MnO·SiO_2 (222)
CaO·SiO_2–Na_2O·SiO_2 (*107*)
CaO·SiO_2–SrO·SiO_2 (*60, 141*)
CaO·SiO_2–TiO_2 (216)
CaO·SiO_2·TiO_2–MnO·TiO_2 (238)
CaO·TiO_2–SiO_2 (217)
CdF_2–NaF (182)
CeO_2–Cr_2O_3 (329)
CeO_2–Fe_3O_4 (329)
CeO_2–MgO (*169*, 329)
CeO_2–Mn_3O_4 (329)
CeO_2–ZrO_2 (329)
(CeO_2, Ce_2O_3)–ZrO_2 (*174*)
CoO–MgO (*168*)
CoO–ZrO_2 (*174*, 332)
Cr_2O_3–MgO (*168*)
Cr_2O_3–ZrO_2 (*174*)
Cs_2O–SiO_2 (319)
Cu_2O–MgO (*169*)
FeO–Al_2O_3 (192)
Fe_2O_3–K_2O–SiO_2 (293–294, 314)
Fe_2O_3–K_2O·Al_2O_3·6SiO_2–SiO_2 (314)
FeO–MgO (311)
Fe_3O_4–MgO (*168*)
FeO–MgO–SiO_2 (267–278, 312, 315)
FeO–MnO–SiO_2 (279–280)
Fe_2O_3–Na_2O–SiO_2 (*79–83, 109–115, 138*)
FeO–Na_2O·Al_2O_3·2SiO_2–SiO_2 (289)
FeO–Fe_2O_3–MgO (*86–87*)
Fe_2O_3–Fe_3O_4–O_2 (*96–97*, 244)
FeO–Fe_2O_3–SiO_2 (288)
FeO–MgO–SiO_2 (315)
FeO–SiO_2 (*38*)
Fe_2O_3–ZrO_2 (*174*)
3FeO·Al_2O_3·3SiO_2–3MgO·Al_2O_3·3SiO_2–3MnO·Al_2O_3·3SiO_2 (*154*)
FeO·SiO_2–MgO·SiO_2 (*143*, 312)
2FeO·SiO_2–2MgO·SiO_2 (223, 313)
2FeO·SiO_2–Na_2O·Al_2O_3·6SiO_2 (234)
KF–3KF·AlF_3 (189)
KF–NaF (179)
K_2O–Na_2O–SiO_2 (*72*)
K_2O–PbO–SiO_2 (241–243)
K_2O–SiO_2 (*33*, 319)
K_2O·Al_2O_3·6SiO_2–MgO (*164*)
K_2O·Al_2O_3·2SiO_2–Na_2O·Al_2O_3·2SiO_2 (*63*)
K_2O·Al_2O_3·6SiO_2–3MgO·4SiO_2·H_2O (*161*)
K_2O·Al_2O_3·2SiO_2–Na_2O·Al_2O_3·2SiO_2–SiO_2 (290–292)
K_2O·Al_2O_3·4SiO_2–SiO_2 (*54*)
2K_2O·As_2O_5–2Na_2O·As_2O_5 (224)
K_2O·B_2O_3–Na_2O·B_2O_3 (221)
K_2O·CrO_3–Na_2O·CrO_3 (225)

$K_2O \cdot MoO_3$–MoO_3 (212)
$K_2O \cdot MoO_3$–$Na_2O \cdot MoO_3$ (226)
$K_2O \cdot SiO_2$–$Na_2O \cdot SiO_2$ (*55*)
$K_2O \cdot 2SiO_2$–$Na_2O \cdot 2SiO_2$ (*56*)
$K_2O \cdot WO_3$–$Na_2O \cdot WO_3$ (227)
$K_2O \cdot WO_3$–WO_3 (213)

La_2O_3–MgO (327)
La_2O_3–ZrO_2 (330)
LiF–3LiF·AlF_3 (191)
LiF–MgF_2 (181)
Li_2O–SiO_2 (*34*, 319)

MgO–Mn_3O_4 (*168*)
MgO–$Na_2O \cdot Al_2O_3 \cdot 6SiO_2$ (*166*)
MgO–NiO (*168*)
MgO–SiO_2 (*39*, *168*, 319)
MgO–SrO (*169*)
MgO–ThO_2–ZrO_2 (*178*)
MgO–TiO_2 (*168*)
MgO–ZrO_2 (*168*, *173*, 202)
MnO–SiO_2 (*40*, 201)
Mn_3O_4–ZrO_2 (*174*, 332)
$MnO \cdot SiO_2$–$MnO \cdot TiO_2$ (*62*)
MoO_3–$Na_2O \cdot MoO_3$ (214)

NaF–$Na_2O \cdot SiO_2$ (206)
NaF–PbF_2 (183)
Na_2O–SiO_2 (*35*, 319)
Na_2O–SiO_2–ZrO_2 (*84*)
Na_2O–TiO_2 (200)
$Na_2O \cdot Al_2O_3 \cdot 2SiO_2$–$Na_2O \cdot 2SiO_2$ (233)
$Na_2O \cdot Al_2O_3 \cdot 2SiO_2$–$Na_2O \cdot SiO_2$–$Na_2O \cdot 2SiO_2$ (233, 295)
$Na_2O \cdot 2CaO \cdot 3SiO_2$–$Na_2O \cdot 2SiO_2$ (*108*)
$5Na_2O \cdot Fe_2O_3 \cdot 8SiO_2$–$Na_2O \cdot 2SiO_2$ (*115*)
$Na_2O \cdot SiO_2$–ZrO_2 (*53*)
$Na_2O \cdot WO_3$–WO_3 (215)
NiO–ZrO_2 (*174*, 332)

PbF_2–PbO (185)
PbF_2–$3PbO \cdot As_2O_5$ (210)
PbF_2–$3PbO \cdot V_2O_5$ (211)
PbO–$PbO \cdot CrO_3$ (218)
PbO–$PbO \cdot MoO_3$ (219)
PbO–$PbO \cdot WO_3$ (220)
PbO–SiO_2 (*41*)
PbO–V_2O_5 (205)
$PbO \cdot CrO_3$–$PbO \cdot SO_3$ (229)
$PbO \cdot MoO_3$–$PbO \cdot WO_3$ (230)

Rb_2O–SiO_2 (319)

SiO_2 (*21–23*)
SiO_2–SrO (*42*)
SiO_2–TiO_2 (*48*)
SiO_2–ZnO (*43*)
SiO_2–ZrO_2 (*47*, 203)
SrO–SiO_2 (319)
SrO–ZrO_2 (*172*)

ThO_2–TiO_2 (331)
ThO_2–ZrO_2 (*49*)

ZnO–ZrO_2 (*174*)

Tabular Index I
Two Oxides

Fig. No.	Al_2O_3	As_2O_5	BaO	BeO	Bi_2O_3	B_2O_3	CaO	CdO	CeO_2	CoO	CrO_3	Cr_2O_3	Cs_2O	Cu_2O	FeO	Fe_2O_3	Fe_3O_4	Ga_2O_3	K_2O	La_2O_3	Li_2O	MgO	MnO	Mn_2O_4	MoO_3	Na_2O	NiO	O_2	PbO	Rb_2O	Sb_2O_3	SiO_2	SO_3	SnO_2	SrO	ThO_2	TiO_2	V_2O_5	WO_3	ZnO	ZrO_2
21–22																															×									
24							×															×																		
325, 323, 27	×						×																																	
28						×	×																																	
29	×																					×																		
30	×																																							
31	×											×																											×	
32							×									×																								
319, 318, 33																			×												×								
319, 318, 34																					×										×								
319, 318, 35																										×					×								
319, 36		×																													×								
325, 323, 319, 37							×																								×								
38															×																×								
319, 168, 39																						×									×								
201, 40																							×								×								
41																													×		×								
319, 42																															×			×					
43																															×							×	
44							×																																
170, 45	×																														×								×
46	×																																			×				
203, 47																															×								×
48																															×					×			
49																																			×				×
168																						×				×													
168									×													×																		
168												×										×																		
168																×						×																		
168																						×		×																
168																						×																		

Tabular Index I
Two Oxides (continued)

Fig. No.	Al_2O_3	As_2O_5	BaO	BeO	Bi_2O_3	B_2O_3	CaO	CdO	CeO_2	CoO	CrO_3	Cr_2O_3	Cs_2O	Cu_2O	FeO	Fe_2O_3	Fe_3O_4	Ga_2O_3	K_2O	La_2O_3	Li_2O	MgO	MnO	Mn_2O_3	MoO_3	Na_2O	NiO	O_2	PbO	Rb_2O	Sb_2O_3	SiO_2	SO_3	SnO_2	SrO	ThO_2	TiO_2	V_2O_5	WO_3	ZnO	ZrO_2
202, 168																						×																			×
170, 168	×																					×																			
169														×								×																			
326, 324, 169							×															×																			
169			×																			×																			
169																						×													×						
169				×																		×																			
329, 169									×													×																			
170	×						×																																	
170	×		×																																					
170	×																									×														
170	×									×																														
170	×																																			×				
170	×																																		×					
171	×			×																																				
171	×													×																											
174, 171	×																																							×
171	×																																			×				
329, 171	×								×																															
171	×																			×																				
328, 171	×																						×																	
171	×																×																								
171	×																	×																							
171	×											×																													
325, 322, 172							×																×																	×
172																																			×					×
172			×																																					×
173				×																																				×
173																						×																		×
174																																							×	×
332, 174																										×														×

Tabular Index I
Two Oxides (continued)

Fig. No.	Al_2O_3	As_2O_3	BaO	BeO	Bi_2O_3	B_2O_3	CaO	CdO	CeO_2	CoO	CrO_3	Cr_2O_3	Cs_2O	Cu_2O	FeO	Fe_2O_3	Fe_3O_4	Ga_2O_3	K_2O	La_2O_3	Li_2O	MgO	MnO	Mn_3O_4	MoO_3	Na_2O	NiO	O_2	PbO	Rb_2O	Sb_2O_3	SiO_2	SO_3	SnO_2	SrO	ThO_2	TiO_2	V_2O_5	WO_3	ZnO	ZrO_2
332, 174										×																														×
174	×																																							×
174												×																												×
174																×																								×
332, 174																								×																×
329, 174									×																															×
186															×							×																		
192	×														×																									
193						×															×																			
194						×																				×														
195						×		×																																
196						×																	×																	
197–198						×																						×											
199					×																							×											
200																										×										×				
204		×																										×												
205																												×									×			
319, 318																														×		×								
319														×																		×								
320	×			×																																				
322, 324, 320				×			×																																	
329, 320				×					×																															
320				×						×																															
320				×								×																													
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320				×																		×																		
320				×																				×																
320				×																						×														
320				×																																				

Tabular Index I
Two Oxides (continued)

Fig. No.	Al_2O_3	As_2O_5	BaO	BeO	Bi_2O_3	B_2O_3	CaO	CdO	CeO_2	CoO	CrO_3	Cr_2O_3	Cs_2O	Cu_2O	FeO	Fe_2O_3	Fe_3O_4	Ga_2O_3	K_2O	La_2O_3	Li_2O	MgO	MnO	Mn_2O_4	MoO_3	Na_2O	NiO	O_3	PbO	Rb_2O	Sb_2O_5	SiO_2	SO_3	SnO_2	SrO	ThO_2	TiO_2	V_2O_5	WO_3	ZnO	ZrO_2
320				×																																					×
321				×																																	×				
320, 324, 322				×			×																																	
324, 322							×																	×																
324, 323							×							×																										
325, 323							×																														×			
326, 324							×			×																														
326, 324							×																				×													
326, 324							×																													×				
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327									×											×		×																		
329							×		×																															
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329									×								×																							
329									×															×																
330																				×																				
331																																				×	×			×
208		×																	×																×	×				
209		×																								×														
212																			×					×																
213																			×																				×	
214																								×	×															
215																										×													×	
218											×																		×											
219																								×					×											
220																													×										×	

Tabular Index II
Three Oxides

Tabular Index II
Three Oxides

Fig. No.	Al_2O_3	As_2O_3	BaO	BeO	Bi_2O_3	B_2O_3	CaO	CdO	CeO	CoO	CrO_3	Cr_2O_3	Cs_2O	Cu_2O	FeO	Fe_2O_3	Fe_3O_4	Ga_2O_3	K_2O	La_2O_3	Li_2O	MgO	MnO	Mn_3O_4	MoO_3	Na_2O	NiO	O_2	PbO	Rb_2O	Sb_2O_3	SiO_2	SO_3	SnO_2	SrO	ThO_2	TiO_2	V_2O_5	WO_3	ZnO	ZrO_2
53							×																			×						×					×				×
54	×																		×												×									
72, 55, 56																			×							×					×									
57							×														×										×									
248–66, 58							×								×																×									
59			×				×																								×									
60							×																								×			×						
61							×																								×					×				
62																							×								×					×				
239–40, 73	×						×												×																					
74	×						×																			×														
103–106, 75, 76							×												×												×									
107–108, 77, 78							×																			×					×									
109–15, 79–83																×										×					×									
84																										×					×									×
85	×						×															×																		
116–22, 88, 89							×															×									×									
86, 87															×	×						×																		
123–26, 90, 91	×						×									×																								
157, 127–34, 92	×						×																								×									
158, 94	×																					×									×									
95	×																														×								×	
244, 97, 96																×	×										×													
159	×														×																×									
167, 160	×																		×												×									
216–17							×																								×					×				
221						×													×							×														
222							×																×								×									
267–78, 223															×							×									×									
224		×																	×							×														
225											×								×							×														
226																			×						×	×														

Tabular Index II
Three Oxides (continued)

Fig. No.	Al_2O_3	As_2O_3	BaO	BeO	Bi_2O_3	B_2O_3	CaO	CdO	CeO_2	CoO	CrO_3	Cr_2O_3	Cs_2O	Cu_2O	FeO	Fe_2O_3	Fe_3O_4	Ga_2O_3	K_2O	La_2O_3	Li_2O	MgO	MnO	Mn_3O_4	MoO_3	Na_2O	NiO	O_2	PbO	Rb_2O	Sb_2O_3	SiO_2	SO_3	SnO_2	SrO	ThO_2	TiO_2	V_2O_5	WO_3	ZnO	ZrO_2
227																			×							×													×		
228																									×	×													×		
229											×																	×				×								
230																									×			×										×		
231					×																				×			×												
232					×																							×										×		
295, 233	×																		×							×					×								
241–43																			×									×			×								
279–80															×								×								×								
281–87						×	×																								×								
288															×	×															×								
175				×			×																																×
176				×					×																														×
177							×																												×				×
178																						×													×				×

Tabular Index III
Four Oxides

Fig. No.	Al_2O_3	As_2O_5	BaO	BeO	Bi_2O_3	B_2O_3	CaO	CdO	CeO_2	CoO	CrO_3	Cr_2O_3	Cs_2O	Cu_2O	FeO	Fe_2O_3	Fe_3O_4	Ga_2O_3	K_2O	La_2O_3	Li_2O	MgO	MnO	Mn_3O_4	MoO_3	Na_2O	NiO	O_2	PbO	Rb_2O	Sb_2O_5	SiO_2	SO_3	SnO_2	SrO	ThO_2	TiO_2	V_2O_5	WO_3	ZnO	ZrO_2
63, 290–92	×																		×							×						×									
165, 67, 68	×						×																			×						×									
102, 69, 70, 99, 307–309	×						×															×										×									
164, 161	×																		×			×										×									
63, 162	×																		×							×						×									
297, 163	×						×													×												×									
166	×																					×				×						×									
237							×															×										×					×				
238							×																×									×					×				
234, 289	×														×											×						×									
293–94	×															×			×													×									
236, 298	×						×																									×					×				
235, 299–306	×						×									×																×									
310	×														×	×																×									

Tabular Index IV
Five Oxides

Fig. No.	Al_2O_3	As_2O_5	BaO	BeO	Bi_2O_3	B_2O_3	CaO	CdO	CeO_2	CoO	CrO_3	Cr_2O_3	Cs_2O	Cu_2O	FeO	Fe_2O_3	Fe_3O_4	Ga_2O_3	K_2O	La_2O_3	Li_2O	MgO	MnO	Mn_3O_4	MoO_3	Na_2O	NiO	O_2	PbO	Rb_2O	Sb_2O_5	SiO_2	SO_3	SnO_2	SrO	ThO_2	TiO_2	V_2O_5	WO_3	ZnO	ZrO_2
64, 296	×						×												×			×										×									
65, 66, 100, 101	×						×															×				×						×									

Tabular Index V
Oxides and Fluorides

Fig. No.	Al_2O_3	As_2O_3	BaO	BeO	Bi_2O_3	B_2O_3	CaO	CdO	CeO_2	CoO	CrO_3	Cr_2O_3	Cs_2O	Cu_2O	FeO	Fe_2O_3	Fe_3O_4	Ga_2O_3	K_2O	La_2O_3	Li_2O	MgO	MnO	Mn_3O_4	MoO_3	Na_2O	NiO	O_2	PbO	Rb_2O	Sb_2O_3	SiO_2	SO_3	SnO_2	SrO	ThO_2	TiO_2	V_2O_5	WO_3	ZnO	ZrO_2	AlF_3	BaF_2	CaF_2	CdF_2	KF	LiF	MgF_2	NaF	PbF_2
25																																									×							×	
26	×																																											×							
71, 50																																										×		×					×	
51, 52	×																																									×							×	
98	×																																									×		×					×	
179																																													×			×	
180																																												×					×	
181																																															×	×		
182																																													×				×	
183																																																	×	×
184																																													×			×		
185																												×																							×
187																																												×			×			
188, 189																																												×			×			
190, 191																																												×				×		
206																										×						×																	
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CERAMIC ABSTRACTS

Compiled by the

AMERICAN CERAMIC SOCIETY

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The bold-face number following the journal name is the volume; the issue number is in brackets, followed by the page numbers, then the year in parentheses.

April, 1938
17—4

Abrasives

Abrasion resistance of a low alloy steel (medium manganese). F. A. Wickersham. *Metal Progress*, **30** [1] 64–66 (1936).—W. describes Carnegie-Illinois' "AR" steel (0.35 to 0.50% C, 1.50 to 2.00 Mn, 0.050 maximum P, 0.055 maximum S, 0.15 to 0.30 Si). As-rolled product has a tensile strength of 100,000 to 125,000 lb./in.^{2} and a Brinell hardness of 200 to 250. Tensile strength may be increased to 150,000 lb./in.^{2} by heat treatment. Some general discussion on the theories and on the relation of abrasion resistance to other physical properties is included, but no specific data for the steel in question are given. F.P.P.

Five theorems on mechanical surfacing. Charles Dévé. *Rev. Optique*, **15** [6–7] 201–14; [8] 241–57 (1936).—D. gives the following theorems to aid in the understanding and application to optical grinding of a surfacing mechanism previously described (*ibid.*, **9**, 481 (1930); **10**, 201 (1931)): (1) only the rule of equal rotations can be applied to a small disk held by a central cap on a larger rotating plate, but not overlapping the latter; (2) when the upper plate is larger than the lower, uniform wear of either is impossible; (3) when a concave surface is supported by a central cap on a rotating ball, the instantaneous axis of rotation of the concave surface on the ball is perpendicular to the axis of the surface in the plane containing the axes of both the surface and the ball; (4) when a concave surface and ball of the same angular opening are turned together on a common spindle, the surface is worn more rapidly than the ball, but this law is reversed in surfacing on a spindle of adjustable relative rotation; (5) by judicious selection of the instantaneous axis of rotation, it is possible to insure uniform wear along 3 concentric rings and at the center of a glass or spherical tool. F.P.P.

Grinding cracks. Adam M. Steever. *Metal Progress*, **27** [5] 52–53, 68 (1935).—The final operations (finish grinding, polishing, and lapping) in the manufacture of dies and tools for punching, forming, and cutting are critical, for it is here that a large number of such tools are ruined. Photographs of typical grinding cracks are shown. Grinding cracks may be revealed by boiling the tool from 15 to 30 min. in 50% HCl or HNO_3. They may be distinguished from quenching cracks by their large number and their parallel, frequently mosaic appearance. Noticeable surface discoloration indicates faulty, too hot grinding, which may set up expansion stresses capable of subsequently causing cracks. For finish grinding, a soft wheel, light cuts with rapid passes, and generous flow of coolant should be used; the part should be stress-relieved at 300°F just before the finishing touches are applied. F.P.P.

Metal cutting and selection of cutting fluids. Anon. *Lubrication*, **22** [11] 121–32 (1936).—Machine operations wherein cutting fluids are required involve (1) turning and boring, (2) drilling and reaming, (3) shaping and planing, (4) milling and hobbing, (5) broaching, (6) threading and tapping, and (7) grinding. The functions of a cutting fluid are to (1) dissipate heat, (2) lubricate, (3) enable the cutting tool or grinding wheel to produce a satisfactory finish, (4) prolong the life of the cutting [illegible], (5) prevent rust and corrosion, and (6) carry and flush away turning chips and grinding dirt. The various types of fluids used are straight mineral oil; mineral lard oil; sulfurized mineral lard oil and sulfurized mineral oil; and soluble oil. H.E.S.

Polishing cement. Mid-West Abrasive Co. *Chem. Industries*, **41** [2] 156 (1937).—A cement for polishing wheels, which requires no heat in preparation, has been developed. Through use of a special thinner, cement of any density can be made up so that wheels of varying densities can be surfaced uniformly. P.G.H.

PATENTS

Abrading apparatus. W. L. KEEFER (Pangborn Corp.). U. S. 2,108,005, Feb. 8, 1938 (July 25, 1935).

Abrading apparatus. W. L. KEEFER (Pangborn Corp.). U. S. 2,108,006, Feb. 8, 1938 (July 25, 1935; June 26, 1937; renewed Nov. 9, 1937). In an abrading machine, at least one disklike member mounted for rotation, a plurality of abrasive-propelling blades mounted on the member, means for feeding abrasive to the blades, means for rotating the member for propelling the abrasive at abrading velocities, and a stationarily supported rebound abrasive guard mounted to one side of the member, one edge of the guard terminating in a plane normal to the axis of rotation of the member and passing through a region adjacent the junction of the member and the blades, the guard extending in an axial direction away from the blades.

Abrasive-coated article manufacture. R. C. BENNER AND R. L. MELTON (Carborundum Co.). Can. 370,484, Dec. 14, 1937 (June 25, 1935). G.M.H.

Abrasive sleeve and method of forming. D. E. MULHOLLAND. U. S. 2,106,186, Jan. 25, 1938 (Nov. 2, 1936).

Automatic grinding and polishing machine. F. ZEISSL. Brit. 477,853, Jan. 19, 1938 (July 10, 1936).

Buffing method and apparatus. H. D. STEVENS (Firestone Tire and Rubber Co.). U. S. 2,106,442, Jan. 25, 1938 (April 24, 1935).

Buffing section unit and assembly. L. W. KREILICK AND H. R. TAYLOR (Yerges Mfg. Co.). U. S. 2,106,610, Jan. 25, 1938 (May 3, 1937).

Cutter grinding machine. F. DECKEL (trading as F. Deckel, Prazisionsmechanik und Maschinenbau). Brit. 477,854, Jan. 19, 1938 (July 22, 1935).

Device for sharpening knives, scissors, etc. P. DOPPLER. Brit. 477,545, Jan. 12, 1938 (July 4, 1935).

Grinder. H. J. CRINER (A. G. Bush). U. S. 2,107,105, Feb. 1, 1938 (July 29, 1937). A grinding machine for sharpening scalloped blades is described.

Grinding or abrasive wheels and their manufacture. NORTON GRINDING WHEEL CO., LTD. (Norton Co.). Brit. 478,028, Jan. 26, 1938 (Dec. 15, 1936).

Grinding device. W. A. WEED. U. S. 2,107,921, Feb. 8, 1938 (Nov. 11, 1936).

Grinding wheels, etc. NORTON GRINDING WHEEL CO., LTD., AND W. HADDOCK. Brit. 478,242, Jan. 26, 1938 (June 11, 1936).

Honing machine. A. M. JOHNSON (Barnes Drill Co.). U. S. 2,106,216, Jan. 25, 1938 (Jan. 28, 1935).

Machine for grinding screw threads in chasers. REISHAUER-WERKZEUGE AKT.-GES. Brit. 478,240, Jan. 26, 1938 (Jan. 6, 1936).

Machine tool. A. M. JOHNSON (Barnes Drill Co.). U. S. 2,106,217, Jan. 25, 1938 (Nov. 29, 1935).

Means for sharpening scissors. F. KRAHENBUHL AND M. MEIER. Brit. 478,181, Jan. 26, 1938 (July 8, 1936).

Method of honing. K. W. CONNOR (Micromatic Hone Corp.). U. S. 2,108,029, Feb. 8, 1938 (April 27, 1936).

Method of manufacturing grinding rings from emery and a medium made of raw rubber. H. RANDALL. Brit. 478,180, Jan. 26, 1938 (July 5, 1937).

Portable polishing machine. H. J. PATTISON AND W. K. BARTON (Briggs Mfg. Co.). U. S. 2,106,535, Jan. 25, 1938 (Feb. 19, 1936).

Roll grinding machine. EDWARD HUTCHENS (Utility Mfg. Co.). U. S. 2,106,215, Jan. 25, 1938 (Dec. 15, 1934).

Sanding wheel. ERNEST DUNFORD (Landis Machine Co.). U. S. 2,107,411, Feb. 8, 1938 (March 11, 1936).

Testing and classifying bonded granular bodies. R. L. MELTON (Carborundum Co.). U. S. 2,107,186, Feb. 1, 1938 (Dec. 11, 1930). The method of determining the "grade" of a bonded abrasive article comprises subjecting a localized area of the article to a predetermined number of impacts of predetermined magnitude of an impact cutting tool which breaks away abrasive particles and bond in the form of detritus, relieving the cutting tool of the cushioning action of such detritus, and thereafter measuring the depth of the hole so produced.

Unit abrading element. K. W. CONNOR (Micromatic Hone Corp.). U. S. 2,106,205, Jan. 25, 1938 (April 19, 1934).

Waterproof sandpaper manufacture. BYRON J. OAKES (Minnesota Mining & Mfg. Co.). Can. 370,533, Dec. 14, 1937 (Jan. 31, 1936). G.M.H.

Art and Archeology

American art under the New Deal: murals. MARGARET PRESTON. *Art in Australia*, **3** [69] 51–58 (1937).—The condition of the American artist since the economic crisis of 1929 and the efforts of the Government to assist him are recounted. Rivera is regarded as the best mural artist, followed by Thomas Benton, Orozco, Egas, and L. Bloch. Illustrated. H.H.S.

Anglo-Saxon pottery. J. N. L. MYRES. *Antiquity*, **11** [44] 389–400 (1937).—Decoration was commonly effected by stamps made of bone, wood, or metal. This enables the work of certain potteries or of individual potters to be identified. A large number of urns on which the same stamps have been used have been found in Cambridgeshire, Rutland, Sussex, and elsewhere. 27 illustrations. A.B.S.

Archeological treasures to have shelter. ANON. *Science News Letter*, **32** [849] 40 (1937).—The Government is building a laboratory and storehouse for archeological treasures being found on Jamestown Island, Va. Much pottery and many bottles, as well as an early brick kiln and two lime kilns, have been discovered. P.G.H.

Chessmen and chessboards. A. C. TONNOCHY. *Connoisseur*, **101** [437] 33 (1938).—Early examples of this game which was originated by the Hindus and known in Persia in the 6th Century are carved ivory and bone. In the 18th Century the porcelain industry lent itself to the making of chess sets. A porcelain knight of a set of chessmen in the rococo style is illustrated, as is also the concluding example of modern times, a product of the Meissen factory, in which the chessmen are conceived as marine animals, the curious shapes and markings of which produce a decorative effect. M.E.P.

Chinese ceramics: Cory bequest. R. L. HOBSON. *Brit. Museum Quart.*, **11** [2] 52–53 (1937).—The British

Museum collection has been enriched by a bequest from Reginald R. Cory, consisting mostly of Chinese porcelain with a few specimens of Canton enamel. The K'ang Hsi *famille verte* and *famille rose* porcelains supplement a gap in the Museum collection, particularly in regard to the "birthday plates" typical of this group. Illustrated. See "Bequest—," *Ceram. Abs.*, **16** [2] 55 (1937). H.H.S.

Chinese ceramics: H. W. Kent collection. BASIL BURDETT. *Art in Australia*, **3** [69] 40–48 (1937).—The Kent collection is now on loan to the Australian National Gallery, Melbourne. Dominant among the pieces are the mortuary figurines of the early dynasties, chiefly T'ang. Illustrated. See "Additions—," *Ceram. Abs.*, **16** [2] 55 (1937). H.H.S.

Decorating glass: II, Silk screen process. V. H. REMINGTON. *Glass Ind.*, **18** [6] 195–98 (1937).—The silk screen, as adapted to ceramic printing, is really a modern development of stenciling methods. The utilization of a coarse silk screen with a thin paper stencil on the underside is a very important improvement and is believed to be the forerunner of shellacked and other treated paper stencils. The heart of the screen printing method is the screen plate itself. The screen is usually made of unstamped silk bolting cloth stretched on a frame. Knife-cut paper and film-paper screen stencils are mounted on the silk plate in accordance with directions supplied by manufacturers. **III.** *Ibid.*, [7] 236–40.—The use of photographic principles has made it possible to produce long wearing screens at low cost. The preparation of the screen plate is based on the discovery that a colloid, such as glue, gelatin, or gum arabic, containing a bichromate is rendered insoluble in water when exposed to light. Details of both the direct and gravure methods of making photographic screen plates are given, the latter being made by the carbon tissue or gelatin sheet methods. The methods of printing the color through the screen, preparation of the color, and drying are discussed. **IV, Miscellaneous decorating methods.** *Ibid.*, [8] 267–71.—Among the older decorating methods are rubber stamp, limited due to the thin layer of color applied; ice decoration, in which colored or colorless, low melting, granular glass approximately 50- to 150-mesh in size is poured over decorative impressions of oils to which it adheres; banding, lining, and painting with vitrifiable colors; etched or engraved steel plate transfer; luster decoration with metallic resinates dissolved in suitable solvents such as lavender oil; metallic decoration, with gold, silver, and platinum applied in paste form consisting of oil, flux, and finely divided metal; and the decalcomania transfer methods. Carefully controlled heat conditions are required in firing the decorations. Methods of testing the alkali, acid, and sulfide resistance of decorating colors are outlined. For Part I see *Ceram. Abs.*, **16** [8] 231 (1937). E.J.V.

Economical method of decorating whiteware. WALTER D. FORD. *Ceram. Age*, **28** [6] 182 (1936).—F. outlines developments in photographic relief technique in the design and decoration of ceramic ware. The process includes (1) drawing a design suitable for use as a decoration, (2) producing a photographic relief of this design in a mold, (3) forming the ceramic piece, and (4) applying a glaze to this piece in order to bring out the design in the desired manner. See *Ceram. Abs.*, **15** [6] 172 (1936); **16** [9] 266 (1937). F.G.H.

Famous White House chinaware: XVII, Rutherford Birchard Hayes administration (1877–1881). ANON. *Ceram. Age*, **27** [1] 270 (1936).—Chinaware decorations of this period comprised American flowers, vegetables, and bird and animal life in natural settings. **XVIII, James Abram Garfield administration (1881–1881).** *Ibid.*, p. 272.—A low fruit dish, a salad bowl, and a plate of Haviland ware represent this administration. **XIX, Chester Alan Arthur administration (1881–1885).** *Ibid.*, [2] 20.—This chinaware shows the color and design of the ornate Victorian period, trending to deep colorings and large patterns. Two plates are shown. **XX, Grover Cleveland administration (1885–1889).** *Ibid.*, p. 22.—The Wedgwood dishes of blue, gold, and pink characterized this administration. **XXI, Benjamin Harrison administration (1889–1893).** *Ibid.*, [3] 56.—Mrs. Benjamin Harrison designed the decoration for the chinaware which was embellished with a motif of Indian corn and goldenrod in gold and maize. The ware was prepared by Limoges-Haviland. **XXII, Grover Cleveland (second) administration (1893–1897).** *Ibid.*, p. 58.—Two unusual series of plates in use during the second Cleveland administration are described. **XXIII, William McKinley administration (1897–1901).** *Ibid.*, [4] 92.—Modern Minton chinaware, having a bluish green border with edges of gold, was introduced. **XXIV, Theodore Roosevelt administration (1901–1909).** *Ibid.*, p. 94.—An entirely new set of official state dinnerware was produced by Wedgwood. The ware is designed in a simple colonial pattern of white and gold with each piece bearing an accurate replica in colors of the great seal of the United States adopted in 1782. **XXV, William Howard Taft administration (1909–1913).** *Ibid.*, [6] 164.—Several characteristic pieces of Dresden china identify this administration. **XXVI, Woodrow Wilson administration (1913–1921).** *Ibid.*, p. 166.—The first native ware as the standard service for the executive mansion was introduced by President Woodrow Wilson. This ware, outstanding for its design and dignity, is the famous Lenox Belleek manufactured by Lenox, Inc., Trenton, N. J. The service plate is 11 in. in diameter, slightly larger than the conventional size. The outer border is etched in gold in the design of the Adam period. There follows a field of rich blue, terminating in an inner narrow border bearing the Stars and Stripes. The president's seal is raised in gold in the center of the plate. The dinner plates of this set are in two tints, ivory-colored and cream-white, with the decorations in rolled gold. Each plate is edged with a narrow border corresponding to the inner border on the service plates and similarly portraying the Stars and Stripes in formal arrangement, one star alternating with a group of stripes. Each piece is decorated with the president's seal which is placed between the two borders. **XXVII, Warren Gamaliel Harding administration (1921–1923).** *Ibid.*, **28** [1] 18 (1936).—Additional Lenox ware represents this administration. **XXVIII, Calvin Coolidge administration (1923–1929).** *Ibid.*, p. 20.—The Coolidge china is the Syracuse china of the Onondaga Pottery Co. It has an attractive blue rim over which is etched in gold a formal design incorporating flowers and leaves in scroll effect. In the center of each flat piece is an ornate gold

star of intricate design. **XXIX, Herbert Clark Hoover administration (1929–1933).** *Ibid.*, [2] 52.—The Lenox ware of previous administrations continued in use. Specimens of prominent pieces are illustrated. **XXX, Franklin Delano Roosevelt administration (1933–).** *Ibid.*, p. 54.—A complete new set of Lenox Belleek shows a distinct departure in the dinner service, being characterized by far less formality in design and at the same time conveying definite excellence and elegance. The pattern is edged with a narrow gold band. Inside this is a wider band of the national blue attractively decorated with small gold stars at regular intervals. Following, for a width of about one-half inch, there is a lighter tracery of gold having for its motif the rose and three plumes taken from the Roosevelt family coat of arms. The president's seal appears in subdued colors against the ivory background of the ware. The center of the plates has no decoration whatever. Illustrated. See *Ceram. Abs.*, **15** [3] 81 (1936). F.G.H.

Late geometric Attic amphora. M. ROBERTSON. *Brit. Museum Quart.*, **11** [2] 56–57 (1937).—A vase of the 8th Century B.C., transitional between the geometric style which lasted for centuries and the orientalized style which suddenly supplanted it, has been acquired by the Museum. The design of a lion killing a deer is partly geometric and partly pictorial. H.H.S.

Long Barrow in Brittany. S. PIGGOTT. *Antiquity*, **11** [44] 441–55 (1937).—Brief descriptions of neolithic pottery strengthen the argument that the Long Barrows in England originated in Brittany. A.B.S.

Ming porcelain and underglaze *rouge-de-fer*. HELEN COMSTOCK. *Connoisseur*, **101** [437] 39 (1938).—Examples showing the *rouge-de-fer* under the glaze should be attributed to the Ming period. In the Ch'ien Lung, Ch'ing, Yung Cheng, and Chia Ching reigns it is used over the glaze as an enamel. Pieces similar in design and color having *rouge-de-fer* under the glaze were formerly attributed to these periods but the Ming reign marks on them are now being accepted. M.E.P.

Pottery from Abyssinia. A. DIGBY. *Brit. Museum Quart.*, **11** [2] 54–55 (1937).—Claud Russell has presented to the Museum a collection of pottery consisting mostly of cooking vessels, cups, and other domestic ware made of a thick coarse paste burnished black. A most interesting object is a pottery incense burner over which clothes were stretched on a wicker frame to give them a pleasant scent. The importance of the collection is enhanced by the economic and political changes now taking place in Abyssinia which will probably end in the disappearance of these aboriginal industries. H.H.S.

Roman villa in Sussex. S. E. WINBOLT. *Discovery*, **18** [211] 207–10 (July, 1937).—A villa exceptionally rich in Samian, Castor, New Forest, and other kinds of pottery, built in the reign of Hadrian, has been found deeply buried in a field at Wiggonholt. Sweat baths, etc., are illustrated. The cost of excavating is discussed. H.H.S.

"Soft" glazes of low thermal expansion. R. F. GELLER, E. N. BUNTING, AND A. S. CREAMER. *Jour. Research Nat. Bur. Standards*, **20** [1] 57–66 (1938); R.P. 1064. Price 5¢.—Compositions in the ternary field PbO–B_2O_3–SiO_2 were studied as potential glazes both with and without the addition of 5% Al_2O_3. Compositions within a very small field (25 to 40% PbO, 15 to 30% B_2O_3, and 40 to 55% SiO_2) show promise as glazes maturing at temperatures below 1150°C on talcose bodies of relatively low thermal expansion. Low resistance to solution by weak acids may limit their application to ware which does not come in prolonged contact with food. R.A.H.

Strike gold, music, art in the world's oldest city. ANON. *Science News Letter*, **31** [843] 357 (1937).—An expedition from the University of Pennsylvania has discovered in the stone age city of Tepe Gawra much evidence of advanced civilization. The painted pottery was fired in closed pottery kilns. Round shafts 7 ft. deep lead to a series of underground chambers. The chambers were closed kilns and the shaft permitted indirect firing with perfectly controlled temperature. See *Ceram. Abs.*, **17** [1] 4 (1938). P.G.H.

Style in American dinnerware. J. P. THORLEY. *Ceram. Age*, **28** [3] 75–76 (1936). F.G.H.

Syrian city of Tilbarsib. M. E. L. MALLOWAN. *Antiquity*, **11** [43] 328–39 (1937).—Prehistoric pottery of three distinct groups indicates a date of B.C. 2500 to 2000. A.B.S.

True gold paints for glass and porcelain industries. WALTER MEYER. *Farbe & Lack*, **1937**, pp. 437–38; abstracted in *Chem. Zentr.*, **1937**, ii, 3794.—M. describes the manufacture of different true gold paints for glass and porcelain painting. M.V.C.

BOOKS

Henley's Twentieth Century Book of Formulas, Processes, and Trade Secrets. Edited by GARDNER D. HISCOX. Revised and enlarged by T. O'Conor Sloane. Norman W. Henley Publishing Co., New York, 1937. 883 pp. Price $4.00. Reviewed in *Ceram. Age*, **30** [4] 118 (1937).—Under the main heading of ceramics, a considerable number of formulas are given for the preparation of colors, pottery bodies and glazes, colored and white glass, porcelain, stoneware bodies, and other ware. F.G.H.

Old Wedgwood. JEAN GORELY. Wedgwood Club, Boston, Mass. 62 pp. Reviewed in *Ceram. Age*, **30** [4] 121 (1937).—G. presents a review giving information on activities of the organization, reprints of papers, letters, and other data. See *Ceram. Abs.*, **16** [2] 56 (1937). F.G.H.

Scandinavian Archaeology. HAAKON SHETELIG AND HJALMAR FALK. Translated by E. V. Gordon. Oxford Univ. Press, 1937. Price 1 guinea. Reviewed in *Discovery*, **18** [212] 251 (1937). H.H.S.

PATENTS

Designs for:

Bowl. YUKIO BUMA (Morimura Bros., Inc.). U. S. 108,360, Feb. 8, 1938 (Dec. 29, 1937).

Candlestick. R. A. KELLY (United States Glass Co.). U. S. 108,208, Feb. 1, 1938 (Nov. 11, 1937).

Covered candy jar. R. A. KELLY (United States Glass Co.). U. S. 108,209, Feb. 1, 1938 (Nov. 11, 1937).

Covered dish. R. A. KELLY (United States Glass Co.). U. S. 108,210, Feb. 1, 1938 (Nov. 11, 1937).

Covered jar. R. A. KELLY (United States Glass Co.). U. S. 108,083, Jan. 25, 1938 (Nov. 11, 1937). U. S. 108,204, Feb 1, 1938 (Nov. 11, 1937).

Creamer. YUKIO BUMA (Morimura Bros., Inc.). U. S. 108,358, Feb. 8, 1938 (Dec. 29, 1937).

Cream pitcher. R. A. KELLY (United States Glass Co.). U. S. 108,206, Feb. 1, 1938 (Nov. 11, 1937).

Cup. R. A. KELLY (United States Glass Co.). U. S. 108,205, Feb. 1, 1938 (Nov. 11, 1937).

Drinking glass. E. W. FUERST (Libbey Glass Co.). U. S. 108,200, Feb. 1, 1938 (Dec. 13, 1937).

Glass. MORRIS SHAPIRO. U. S. 108,220, Feb. 1, 1938 (Nov, 2, 1937).

Goblet. GEORGE SAKIER (Fostoria Glass Co.). U. S. 108,219, Feb. 1, 1938 (Nov. 24, 1937).

Jar. YUKIO BUMA (Morimura Bros., Inc.). U. S. 108,361, Feb. 8, 1938 (Dec. 29, 1937). O. C. NOBLE (Tygart Valley Glass Co.). U. S. 108,091, Jan. 25, 1938 (Dec. 7, 1937). FRASIER SMITH (Hazel-Atlas Glass Co.). U. S. 108,223, Feb. 1, 1938 (Dec. 20, 1937).

Jug. YUKIO BUMA (Morimura Bros., Inc.). U. S. 108,359, Feb. 8, 1938 (Dec. 29, 1937).

Mayonnaise bowl. R. A. KELLY (United States Glass Co.). U. S. 108,203, Feb. 1, 1938 (Nov. 11, 1937).

Plate. YUKIO BUMA (Morimura Bros., Inc.). U. S. 108,356 and 108,367 to 108,380, Feb. 8, 1938 (Dec. 29, 1937). G. J. HIGGINSON. U. S. 108,079 and 108,080, Jan. 25, 1938 (Nov. 10, 1937).

Salt or pepper shaker. YUKIO BUMA (Morimura Bros., Inc.). U. S. 108,364 to 108,366, Feb. 8, 1938 (Dec. 29, 1937).

Salt shaker. R. A. KELLY (United States Glass Co.). U. S. 108,207, Feb. 1, 1938 (Nov. 11, 1937).

Sugar bowl. YUKIO BUMA (Morimura Bros., Inc.). U. S. 108,357, Feb. 8, 1938 (Dec. 29, 1937).

Teacup. YUKIO BUMA (Morimura Bros., Inc.). U. S. 108,354, Feb. 8, 1938 (Dec. 29, 1937).

Teapot. YUKIO BUMA (Morimura Bros., Inc.). U. S. 108,355, 108,362, and 108,363, Feb. 8, 1938 (Dec. 29, 1937).

Tumbler. E. W. FUERST (Libbey Glass Co.). U. S. 108,072 and 108,073, Jan. 25, 1938 (Nov. 26, 1937).

Cements

Applications of ethyl silicate preparations. ANON. *Chem. Industries*, **39** [2] 145–47 (1936).—Partially hydrolyzed silicic acid ester solutions may be used to cement or bond comminuted materials of all sorts. Refractory crucibles, refractory and acid-resistant brick, and mortar may be bonded by this material. Air dried refractory blocks have been produced which require a load of over 2000 lb./sq. in. to crush. Heating the blocks to 1500°C and cooling reduces the strength somewhat, but does not cause spalling or serious deterioration. Porous silica brick may be impregnated on the surface in order to increase its abrasion resistance. P.G.H.

Approximate glass content of commercial Portland cement clinker. WILLIAM LERCH. *Jour. Research Nat. Bur. Standards*, **20** [1] 77–82 (1938); R.P. 1066. Price 5¢.—The approximate glass content for commercial Portland cement clinker obtained from 21 plants throughout the U. S. was determined by the heat of solution method. It varies from 2 to 21%. The approximate glass content was also determined for these clinker compositions after the clinker had been subjected to special heat treatment in the laboratory. For a given clinker composition, the heat of solution of the clinker and the glass content are dependent on the cooling conditions to which the clinker has been subjected. Relatively high glass contents may be obtained by cooling the clinker rapidly, and relatively low glass contents, by cooling it slowly. See *Ceram. Abs.*, **16** [8] 234 (1937). R.A.H.

Chemical aspects of manufacture and use of Portland cement. E. E. BAUER. *Roads & Streets*, **80** [6] 41–43 (1937).—The chemical compounds found in cement and their characteristics are discussed. B. analyzes the various theories of the hydration and setting of cement. P.G.H.

Gypsum as a chemical raw material. J. S. OFFUTT. *Chem. Industries*, **39** [3] 252–56 (1936).—The uses and production figures of gypsum are presented. P.G.H.

Hydraulic refractory cements: I, Preparation of highly aluminous calcium aluminates. SEIJI KONDO, TOSHIYOSHI YAMAUCHI, AND YASUSHI INAMURA. *Jour. Japan. Ceram. Assn.*, **45** [532] 227–36 (1937).—As the basic study of the manufacture of hydraulic refractory cements consisting mainly of highly aluminous calcium aluminates, four mixtures ($3CaO:5Al_2O_3$, $CaO:2Al_2O_3$, $CaO:3Al_2O_3$, and $CaO:10Al_2O_3$) prepared from C.P. $CaCO_3$ and Al_2O_3 were fired at temperatures ranging from 1300° to 1500°C for 4 hr., and the products were examined for chemical constitution as well as X-ray structure. The mixture $CaO:10Al_2O_3$ did not give a product sufficiently hydraulic and therefore was given up. The chemical and X-ray examinations indicated that the mixtures $3CaO:5Al_2O_3$ and $CaO:3Al_2O_3$ fired at 1300°C contained less than 1% of free lime while those fired at 1500° had no free lime. In the hydraulic compounds, $3CaO:5Al_2O_3$ fired to 1300° consisted of a great deal of $CaO:Al_2O_3$, a little $5CaO:3Al_2O_3$, and a large amount of α-alumina, whereas that fired to 1500° was composed of a large amount of $3CaO:5Al_2O_3$, a little $CaO:Al_2O_3$, and a small amount of α-alumina; the mixture $CaO:3Al_2O_3$ fired to 1300° and 1500° consisted of a great deal of $3CaO:5Al_2O_3$, a little $CaO:Al_2O_3$, and a large amount of α-alumina. Free alumina coexisting with the aluminates was of α form in every case. The amounts of the highly aluminous calcium aluminates produced in the mixtures were proportional to the temperature of firing as well as to their content of alumina. Heating at temperatures between 1300° and 1400° for 4 hr. was sufficient for the mixtures. **II, Change of strength on heating.** *Ibid.*, [533] 313–19.—In studying the lowering of the strength of hydraulic refractory cements on heating, the fired products of the mixtures $3CaO:5Al_2O_3$ and $CaO:3Al_2O_3$ were examined with a thermobalance for the loss on heating of hydrated specimens and for the change in compressive strength of test pieces made of 1:3 mortars by a small-piece testing method. Methods of preventing a decrease in strength of the products were investigated. The loss in weight was very great at temperatures from 200° to 300° and very small at higher temperatures. The loss taking place at 200° to 300° was probably due to the de-

hydration of aluminium hydroxides and hydrated calcium aluminates. The strength of the hardened test pieces made of the fired products decreased noticeably at about 400°, remained almost unchanged up to 1000°, and was recovered gradually at higher temperatures. The refractory cements proved to be superior to Portland cement in respect to the strength of 1:3 mortars and the same after heating. As a method of preventing the refractory cements from decreasing in strength on heating, an introduction of ferric oxide or manganese dioxide to the raw mixtures was more effective than an addition of frits to the fired cements. **III, Refractory properties of the cements and their preparation from natural materials.** *Ibid.*, [534] 373–83.—Results of experiments on the following are given: (1) P.C.E. of the raw mixtures of the cements, with or without the addition of various oxides or frits; (2) thermal linear change of the hydrated cements; (3) softening behavior of hardened test pieces made of the mixture $3CaO : 5Al_2O_3$ fired at 1300°, of the mixture with 2% of ferric oxide added and fired at 1300°, and of a Portland cement, an addition of 3 times of standard quartz sand being added or not; (4) effect of silica added to the mixture upon the properties of the cements; and (5) preparation of the cements from natural raw materials. The results are as follows: (1) The P.C.E. of the mixtures $CaO : 3Al_2O_3$ and $2CaO : 5Al_2O_3$ were cone 37+ and cone 36+, respectively. An addition of 1 to 4% of ferric oxide, manganese dioxide, or frits to their raw mixtures or to the cements lowered the refractoriness by several cones, ferric oxide being most injurious. Silica was harmful. (2) The hydrated cements contracted rapidly at about 300° on account of dehydration. (3) The cements proved to be more refractory under load than the Portland cement. (4) Silica contained in the raw materials reduced markedly the hydraulicity of the cements. (5) For the preparation of the refractory cement from natural raw materials, limestone and diaspore or limestone and Chojo fire clay were compounded, the proportion of limestone being increased (in order not to reduce the hydraulicity of the cements) by the silica contained in the aluminous materials. The fired products together with a suitable grog gave excellent refractory mortars. S.K.

Lime maximum in Portland cement. R. E. Stradling. *Dept. Sci. Ind. Research, Building Research Board Ann. Rept.*, 1934.—S. shows, from an analysis of the results of the phase equilibrium work, that the maximum amount of lime which can be combined under clinkering conditions in a mix of CaO, Al_2O_3, SiO_2, and Fe_2O_3 of Portland cement composition is given by the formula maximum $CaO = 2.80\,SiO_2 + 1.18\,Al_2O_3 + 0.65\,Fe_2O_3$, where the amounts of the oxides are represented as weight percentages. Though this formula can not apply precisely to commercial Portland cements, since it ignores certain minor components, it is adequate for practical purposes. H.E.S.

Processes in manufacture of Portland cement. E. E. Bauer. *Roads & Streets*, **80** [5] 55–60 (1937).—A detailed review of the wet and dry processes for making Portland cement is given. P.G.H.

Reducing firing, color changes, and strength in manganese- and sulfur- containing clinkers. G. Mussgnug. *Mitt. Forsch.-Anstalt. Gutehoffnungshütte Oberhausen A.-G.*, **5** [9] 221–24 (1937).—When making brick and clinkers of Portland cement of Mn and S containing raw materials, the Mn and S compounds existing in the clinker readily enable the determination of the conditions under which the material was fired. The color of the clinker powder changes from dark gray to chocolate brown under reducing firing, but as this happens also at very high firing temperature by the dissociation of the higher Mn oxides, the presence of sulfide sulfur in the clinker is a surer indication. Clinkers fired under reducing conditions have a lower initial strength than when fired under oxidizing conditions; this is due to the different hydration velocity which depends not only on the mineralogical composition but also on structure and surface. See *Ceram. Abs.*, **16** [7] 198 (1937). M.H.

Refractory cements and mortars: II. Shoichiro Nagai and Junzo Katayama. *Jour. Japan. Ceram. Assn.*, **45** [532] 219–26 (1937).—Commercial refractory cements described in the previous report and those newly collected from the market were examined for chemical and physical properties. The chemical composition, specific gravity, and fineness of the new samples are compared and discussed. A special method of chemical analysis was devised as follows: the water-soluble part is determined and analyzed; the residue is treated with 5% HCl and the soluble part is separated and analyzed; the second residue is further treated with 10% NaOH and the soluble part analyzed; the residue is analyzed. Sulfate and chloride radicals are estimated with the first water solution. Cylindrical test pieces made of the cements were fired at temperatures varying from 600° to 1300°C. They were tested for compressive strength. Low-refractory cements show comparatively high strength on firing at low temperatures of 800° to 1200° while those of high refractoriness show low strength. The result of a load test is given. For Part I see *Ceram. Abs.*, **16** [11] 340 (1937). S.K.

Research upon pozzuolanas: I, Tests of their zeolitic nature. Quirino Sestini and Luigi Santarelli. *Ann. Chim. Applicata*, **26** [5] 193–206 (1936).—The authors investigate the zeolitic activity of various Roman and Flegrean clay cements (pozzuolanas), using the methods of Biehl and Wittekind (*Ceram. Abs.*, **13** [11] 301 (1934)) and Steopoe (*ibid.*, **10** [8] 544 (1931)). The zeolitic activity of clays tested was rather slight, just about equal to that of the Roman and the Romanian trass; thus this phenomenon assumes secondary importance in the absorption of lime in clayey cements. In the first series of tests, after treating the various clays with calcium nitrate, the lime absorption was sought, exchange being looked for between the clay cements and the calcium salts. This would demonstrate eventually the presence of zeolitic components. The procedure is described, and results for the clay cements of the Collatine, St. Paulo, Bacoli, and Segni areas are given in 3 tables. In all the tests, these Italian materials showed very weak zeolitic action. **II, Flocculation tests.** Flocculation tests were applied to ascertain their effectiveness in judging the values of clay cement materials. Previous authors, notably Vicat, are quoted, Vicat having claimed to be the first to produce flocculation effects in pozzuolanas. Attentively studying the procedure of these earlier workers, the authors were impressed with the increase in the quantity of saturated lime as the material passed from hand to hand; this increased the importance

of the silica up to the clay limit until the aluminum would be lacking entirely. The tests utilized Roman and Flegrean clays, naturally rich in silica and noted as active clays. The procedure is detailed, and results are tabulated for the different clays and mixed cement clays. Results were disappointing as they did not indicate the value or quality of the materials. The flocculation tests seemed only a sign of rapid action in clays studied or a means of differentiation between active clays and those slightly active or inert. **III, Tests of the behavior of mixed clay cements in an excess of H_2O.** A description is given of a double series of tests upon cements, both pure and mixed, subjected to varying proportions (30, 40, or 50% admixtures) of pozzuolanas left to season in water under specific conditions of cold and heat. Tables are given in which the CaO values both as freed or as remaining in solution are emphasized. As these tests were only recently completed, comments on the results or a summary of their significance is not given. K.R.

Roman pozzuolana mortars. QUIRINO SESTINI. *Ann. Chim. Applicata*, **26** [4] 167–73 (1936).—The clayey mortars studied by S. were taken from the ancient breakwater at the port of Civita Vecchia, built by the Emperor Trajan in the 2d Century. Two different kinds of clay were used in the structure, one yellowish gray, the other red-brown. The reddish crystals were characteristic of Roman clay, showing augite and leucite; the yellowish crystals belong to clays in the Flegrea zone. Analysis of their granules showed similar composition (SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO, and SO_3), but in different values, *e.g.*, the yellow clay contained 54 SiO_2, 5.90 CaO, and 2.05% Fe_2O_3 while the red clay contained 43.15 SiO_2, 12 CaO, and 9.35% Fe_2O_3. Mortar prepared from the red clay was much more resistant than that of the yellow clay. Analyses of cement masses containing both kinds of clay are extensively tabulated in this article. The quantity of lime still remaining in these ancient cements compares favorably with proportions found today in the Roman and the Flegrean clays, showing that the lapse of time and continuous action of the sea water have not affected this lime component, which S. emphasizes as a factor determining the solidity and resistance exhibited by these cements and mortars for 2000 years. He compares and discusses his results with those found in the literature from 1815 to 1915 by the four students of ancient cements, Vicat, Rebuffat, Giorgis, and Cenni, finding those of Vicat, 1815 to 1858, most in harmony with his own. K.R.

Structure of Portland cement clinkers: III, Interrelation between the three types of belite. L. MOHR. *Zeiss Nachr.*, **3** [2] 103–10 (1937).—The transformation of type I into type II corresponds to the conversion of form α dicalcium silicate into form β. It can be explained on the assumption that during the cooling there are produced, in the crystals of form α, needles of an unstable intermediate form which in time gradually change in number and size into the stable form of belite II. Types I and II simultaneously occur in a single grain. Belite is also a stable type consisting of form β and differing merely in the arrangement of the inclusions. Belite occurs in three types: belite II and III, having the crystalline structure β $2CaO \cdot SiO_2$, and belite I, α $2CaO \cdot SiO_2$, about to change into β. Another hitherto unknown component of Portland cement clinker is celite, the dark type called celite-a and the light type, celite-b. The latter appears colored and pleochroitic under the mineralogical microscope. Its properties strongly resemble those of the compound $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$, whereas celite-a corresponds to $3CaO \cdot Al_2O_3$. Photos show etched clinkers under metallographic examinations in transmitted natural light, transmitted polarized light, and incident light. For Part II see *Ceram. Abs.*, **17** [2] 55 (1938). L.E.T.

Tricalcium aluminate and the microstructure of Portland cement clinker. LEVI S. BROWN. *Proc. Amer. Soc. Testing Materials*, **37** [Part II], 277–305 (1937).—Recognition of C_3A in Portland cement clinker by microscopic examination is exceedingly difficult. To determine its mode of occurrence, *i.e.*, its relation to the structure of clinker, about 150 experimental clinkers were made ranging from pure C_3A through high-alumina silicate mixes into the field of Portland cement compositions. The charges were examined in thin sections, especially prepared to yield optimum clarity. C_3A crystallizes in large units, enclosing C_3S and CaO when present but tending to exclude C_4AF. In this habit C_3A becomes a matrix or interstitial material which is quite difficult to distinguish because of the close similarity of its optical properties to those of C_3S, its presence usually in minor amounts, and general lack of crystal outlines in silicate mixes. Its presence is demonstrated indirectly through its control over the orientation of C_4AF crystallites which show a common mass or field birefringence over large, roughly equidimensional areas. The common lack of such criteria in commercial clinker indicates that crystalline C_3A is not present in the amounts generally calculated. R.A.H.

White Portland cements. M. YA. BYCHKOV AND K. S. ZATZEPIN. *Tsement*, **5** [9–10] 16–20 (1937).—The addition to the batch of 3% KCl and $CaCl_2$ adds considerably to the whiteness of the cement. If these compounds are introduced before clinkering, the content of iron compounds in the cement decreases. The best addition is $CaCl_2$. White Portland cement with this addition has higher mechanical strength than that without additions. Mineralogically it shows an absence of iron-containing mineral and consists of completely colorless grains. P.B. & E.S.

PATENTS

Colliery shale utilization. N. V. S. KNIBBS AND A. P. PEHRSON (Continental Investment Syndicate, Ltd.). Can. 370,989, Jan. 3, 1938 (March 30, 1937). The process comprises molding a cementitious material obtained from calcining carbonaceous shale with limestone or other calcium carbonate and hardening by the action of steam under pressure. G.M.H.

Hydraulic gypsum cement material and process of manufacturing. RUMFORD CHEMICAL WORKS. Brit. 477,743, Jan. 19, 1938 (May 14, 1936).

Enamel

Advances in the enamel industry. W. O. *Emailwaren-Ind.*, **14** [28–29] 201 (1937).—New patents dealing with (1) the obtaining of a heat-stable enamel coat, (2) deënameling, (3) improving the opacifying effect of ZnS, and (4) gas opacification are discussed. M.V.C.

Black spots in sheet-iron enamel. LANG. *Illustr. Ztg. Blechind.*, **66**, No. 26 (1937); abstracted in *Emailwaren-Ind.*, **14** [31–32] 224 (1937).—Metallic oxides (antimony and zinc) may be reduced when melting enamel, forming black spots. Particles of flint stones from the mill may also produce black spots. M.V.C.

Consistency of eight types of vitreous enamel frits at and near firing temperatures. WILLIAM N. HARRISON, ROBERT E. STEPHENS, AND STEPHEN M. SHELTON. *Jour. Research Nat. Bur. Standards*, **20** [1] 39–55 (1938); R.P. 1063. Price 10¢.—Two sheet-iron ground-coat frits, representing the "hard" and "soft" types often mixed in a single slip, behaved as viscous liquids at and near their firing temperatures. Four types of cover-coat frits behaved, not as viscous liquids, but as complex or non-Newtonian liquids at and near their firing temperatures. The data for these compositions were quite systematic. The types represented in this group were (*a*) an "ordinary," (*b*) a very opaque, and (*c*) an acid-resisting cover coat for sheet iron and a leadless dry-process frit for cast iron. The two frits containing lead, *viz.*, a dry-process frit with about 10% of lead oxide and a wet-process frit for cast iron, containing about 40% of lead oxide, behaved not as viscous liquids at the temperatures studied but as complex liquids, exhibiting erratic behavior possibly associated with instability and thixotropy. After heating for several hours in the range of firing temperatures, these frits gave speed-deflection curves more in conformity with those of the other compositions studied. For all the frits studied, the change in viscosity or apparent viscosity with temperature was very large, a decrease in temperature from 950° to 750°C causing as much as a 100-fold increase in the viscosity of some specimens. Because of the apparent thixotropy and instability of some of the cover coats and because the apparent viscosities of the cover coats changed both with temperature and with speed of rotation, it is difficult to make simple comparisons of the frits studied. Most of them may be compared, however, on the basis of apparent viscosity at constant torque in the apparatus. At a selected temperature and torque, the apparent viscosity of the acid-resisting frit for sheet iron was 28 times greater than that of the high-lead wet-process frit for cast iron and 12 times greater than that of the "ordinary" sheet-iron cover coat. The other frits had apparent viscosities between the latter two. The two sheet-iron frits mentioned above were brought to equal apparent viscosities by a temperature difference of 125°C. The highest apparent viscosity measured was nearly 400 times as high as the lowest, the values being 61,000 and 155 poises, respectively. On the average, the viscosity or apparent viscosity of enamels under firing conditions is estimated to be on the order of 4000 poises. R.A.H.

Control in the pickling room. P. C. STUFFT. *Amer. Enameler*, **11** [1] 17–18, 26 (1938).—S. gives methods for controlling alkaline cleaner and neutralizer and for determining the iron content in the acid. The titrating apparatus is illustrated. H.C.G., JR.

Corrosion of metals: I, Mechanism of corrosion processes. R. M. BURNS. *Bell System Tech. Jour.*, **15** [1] 20–38 (1936).—The application of electrochemical methods to corrosion investigations is outlined. B. discusses the position of the potential of a metal in regard to its environment and the trend of this potential with time, pointing out that it is thereby possible to determine whether the corrosion process is controlled by reactions occurring at the anodic areas, the cathodic areas, or at both, *i.e.*, whether there is a tendency toward passivity or progressive attack. On the basis of such measurements and with a chemical knowledge of the environments in which metals are used as well as the composition and physical state or structure of the metals, it is possible to predict corrosion behavior and to obtain an understanding of corrosion problems usually not possible by ordinary empirical corrosion tests. H.E.S.

Deënameling. HEINRICH KIRST. *Glashütte*, **67** [38] 592–94 (1937).—Sandblasting is preferably used to remove defective enamel from cast-iron ware, while for sheet-iron enamel chemical methods are preferable. Fused caustic soda, hydrofluoric acid, or a solution of hydrofluoric and sulfuric acids is generally used for deënameling. M.V.C.

Development of Norge. ANON. *Amer. Enameler*, **10** [8] 5 (1937).—The development of an industry related to the field of porcelain enamel is shown. H.C.G., JR.

Enameling edges of ware. L. VIELHABER. *Emailwaren-Ind.*, **14** [28–29] 199–200 (1937).—Methods used in Germany and the U. S. to enamel edges of ware are briefly described. In order that the enamel may be able to withstand repeated firing, suitable additions of feldspar and alumina should be made to the batch. M.V.C.

From the Chinese. ANON. *Ind. Bull. A. D. Little, Inc.*, No. 117 (1936).—The process of fusing glass on gold was discovered in ancient China. This discovery was destined to lay the foundation for a thriving 20th-Century industry. The history of porcelain enameling is traced from the early cloisonné and champlevé paintings to the present-day products of porcelain enamel. A little over one hundred years ago an enterprising German started producing porcelain enamel pots and pans. The sudden development of several countries into races of bath-takers made a demand for the cast-iron bathtub with a durable finish of porcelain. Methods of applying, compounding, and firing were found which reduced chipping to a minimum. Opacifiers were developed to reduce the number of coats. Electrical refrigeration turned to porcelain for a finish with five or more years' guarantee. The washing-machine industry and the kitchen-range field are using porcelain for a lasting and beautiful finish. Porcelain enamel's most recent adaptation has been in architecture. Insulated sheets of porcelain-on-steel offer a wide range of possibilities in both remodeling and new construction. Because of this there is reason to believe that the upward surge of porcelain enamel may continue. H.E.S.

Gas radiant tubes applied to an enameling furnace. GEORGE M. PARKER. *Gas*, **13** [11] 35 (1937); *Ceram.*

Age, **30** [1] 8–9 (1937).—Gas-fired radiant-tube furnaces will produce results equal in quality to those of electric furnaces, with lower cost and increased production. . . The continuous enameling furnace at the National Enameling and Stamping Co. plant at Granite City, Ill., was converted from electric heating to radiant gas-fired tubes. This hairpin furnace has 120 ft. of travel in the drying space, 20 ft. in the preheater, and 40 ft. in the hot zone, a total of 180 ft. of oven travel. The electric heating elements along the walls were replaced by radiant gas tubes on both walls and bottom, extending through 120 ft. of furnace travel. The products of combustion continue to give off heat in the preheater and drying zones to an exit temperature of 400°, 80% of the gross heat content of the gas being delivered to the furnace as useful heat. Hot-zone temperatures range from 1550° to 1650°. A year's operation with natural gas at 30¢ as against 1¢/kw.-hr. for electric energy has saved more than $20,000. Repairs have been minor, and production has been increased 20% due to the higher heat input now possible. See *Ceram. Abs.*, **16** [6] 168 (1937). S.S. + F.G.H.

Graphitization of gray cast iron. R. M. Parke, V. A. Crosby, and A. J. Herzig. *Metals & Alloys*, **9** [1] 9–14 (1938).—The anomalous occurrence of ferrite adjacent to a chilled section in cast iron is explained by assuming that graphite can form in both the liquid and the solid state. The assumption also satisfactorily explains the difference between graphite shape in gray and in malleable iron, the mechanism of formation of whorl graphite, density changes during solidification of cast iron, and the rapid graphite formation in gray cast iron as compared with the slow rate of graphite formation during the malleablization of white iron. Twelve photomicrographs support the theory. F.P.P.

International Exhibition of Paris. Anon. *Emaillerie*, **5** [12] 18–19 (1937).—Architectural uses of porcelain enamel are illustrated. See *Ceram. Abs.*, **17** [2] 56 (1938). M.D.

Mechanism of reduction of silicate inclusions in steel by added aluminium. A. Portevin and R. Castro. *Jernkontorets Ann.*, **120**, 738–40 (1936); *Jour. Iron & Steel Inst.* [London], **136** [2] 14A (1937).—The mechanism described by K. Amberg and A. Hultgren (*Jernkontorets Ann.*, **120**, 311–42 (1936)) is considered not to be the only one possible. Dissolved aluminium may reduce the silicate drops without immediate formation of a crystalline phase. This would not form until, on cooling, the solubility for the silicoaluminate in the melt rich in alumina and silica is exceeded. In this way the spherical shape of the inclusions will be preserved. In support, the following experiment is described. From a low carbon steel to which silicon had been added, two 1-kg. test ingots were cast, I without further addition and II with the addition of 0.2% of aluminium. In I, spherical glassy inclusions were found which, according to residue analysis, consisted largely of SiO_2. In II the inclusions were similar but somewhat less transparent, being deep green in dark field illumination. Residue analysis (chlorine method) gave O_{SiO_2} = 0.0155, $O_{Al_2O_3}$ = 0.038%, and O_{FeO} and O_{MnO} nil. Near their circumference the inclusions contained small metallic droplets probably rich in silicon and formed by reduction of SiO_2. No crystals were observed in the inclusions. In their reply (*ibid.*, pp. 740–44), Amberg and Hultgren assume that the Al_2O_3 content in the residue from II may have been largely due to the presence in the matrix of small Al_2O_3 or aluminium silicate crystals precipitated by reaction with dissolved oxygen in the metal, whereas the reaction between aluminium and the silicate inclusions in the short time available would probably not exceed the limit of solubility of Al_2O_3 in the SiO_2 melt, which should be at a moderate amount of Al_2O_3. Their views on the various reaction products from the addition of aluminium to steel are further elaborated.

Palace in the wilds. Anon. *Amer. Enameler*, **10** [8] 10 (1937).—Uses of porcelain enamel in a private home are outlined. H.C.G., Jr.

Porcelain enamel in architecture. Anon. *Emaillerie*, **5** [12] 7–15 (1937); **6** [1] 5–12, 18–19 (1938).—The system used by the Porcelain Steel Buildings Co. is described; the main features of the system are illustrated. Examples of the process of batten and molding used by the Revecon Copper and Brass Co. are given. Both companies use flat enameled sheet steel. By using flanged sheets, paneling is applied to walls by the Small Building Corp. and the Toledo Porcelain Enamel Products Co.; the former makes use of a special molding, but the latter forms panels with tongue and groove to secure the panel without the help of any mold or batten. An example of paneling using flanged panels with welded lugs is presented. See *Ceram. Abs.*, **17** [2] 57 (1938). M.D.

Practice in the enamel shop. Ludwig Stuckert. *Ceram. Age*, **22** [6] 163–65 (1933).—The regenerative and recuperative methods of heat recovery as applied to frit and muffle furnaces in the enameling industry are discussed. Illustrated. See *Ceram. Abs.*, **13** [2] 31 (1934). F.G.H.

Scientific aspects of the problem of pickling of ferrous metals. E. Herzog. *Métaux et Corrosion*, **12**, 52–58 (March, 1937); *Jour. Iron & Steel Inst.* [London], **136** [2] 144A (1937).—H. discusses the nature, physical, and chemical, of the oxides to be removed from steel by pickling, processes of removing them (*a*) mechanically and (*b*) chemically, and the theory of the action of inhibitors, (*a*) salts of arsenic and antimony and (*b*) organic compounds. In an appendix he touches briefly on electrolytic pickling, brittleness due to hydrogen, and oxides in the scale on steel.

Sheet steel and fishscales. Max Schimelbusch. *Illustr. Ztg. Blechind.*, **66** [29] 841–43 (1937); abstracted in *Emailwaren-Ind.*, **14** [31–32] 224 (1937).—Experiments showed that a systematic increase of borax content increased fishscales. Careful pickling had no effect on the appearance of fishscales, but sandblasting of sheet steel under a pressure of 9 to 11 atmospheres was sufficient owing to the fact that a layer rich in carbon, cementite, is formed on the surface. It forms a carbide-like compound at 860°C which disintegrates with the access of moisture. The equilibrium of the enamel is destroyed and fishscales are formed. M.V.C.

Synthetic molding sands: I. H. Reininger and H. Jensch. *Giesserei*, **24** [25] 617–23 (1937).—The chemical composition of natural molding sands, SiO_2 with Al_2O_3 and H_2O, is never very constant, and the grain size varies greatly. Synthetic sands are much more uniform in every

respect and therefore more reliable for foundry purposes. Preparation, properties, and testing are described, and the regeneration of used sands is discussed. **II, Standardized manufacture.** *Ibid.*, [26] 649–54.—Classification of sands according to grain size in various countries is discussed, and the term "dust" is defined. Dust is usually considered as consisting of particles smaller than 0.02 mm. in diameter and silt of particles from 0.02 to 0.053 mm. (American mesh 270). Gas permeability depends on the distribution of grain size and increases with the content of particles larger than 0.1 mm. Water content comprises only the bound water, either chemically, colloidally, or physically bound. Methods of preparation, testing, conveying, and several types of standardized sands are described. M.H.

Theory of inhibitor action and a new method of inhibitor evaluation. W. MACHU. *Korrosion & Metallschutz*, **13**, 1–20 (1937).—A method of measuring the passivifying period and the initial current intensity was used to determine the influence of inhibitors on the solubility of iron in dilute sulfuric acid and on the free pore space and the resistance of the inhibiting layer. The inhibitors studied were A C P Rodine, diorthotolylthiourea, Ferrocleanol, Supra H, Aussiger Sparbeize, dibenzyl sulfide, dibenzyl sulfoxide, quinoline, starch, gum arabic, gelatin, and Turkish red-oil. The results show that the protective action of the inhibitor is not due to the formation of a layer of low porosity. Instead, the inhibitors form an adsorbed layer of high electrical resistance. Any organic compound which can form a layer with a resistance of 3 ohms should be a good inhibitor. A definition of an inhibitor is suggested on the basis of this property. J.B.A.

Use of porcelain enameled sheets in electric substations. ANON. *Emaillerie*, **6** [1] 7–8 (1938).—Porcelain enameled sheet steel electric substations in Cleveland are described. M.D.

Utilization of waste enamel. L. VIELHABER. *Email-waren-Ind.*, **14** [31–32] 219–21 (1937).—Methods of reutilization of waste enamel and that from deënameled ware are briefly discussed. In deënameling, the enamel is removed by pickling with hydrofluoric acid or a mixture of hydrofluoric and sulfuric acids and by immersion in molten caustic soda; the latter is then boiled down, and the sediment is used, after analysis, as new raw material. M.V.C.

White pickling plant for a tinplate rolling mill. ANON. *Demag News*, **11** [C. April] 11–12 (1937); *Jour. Iron & Steel Inst.* [London], **136** [2] 144A (1937).—Particulars are given of a pickling plant using compressed air as the driving medium. The spent air, after passing through a low-pressure air receiver, is recompressed in the circuit to the required working pressure. Illustrated.

BOOK AND BULLETIN

Enameler's Dictionary. Compiled by KENNETH HOSSACK. Ferro Enamel Corp., Cleveland, 1937. 80 pp. Reviewed in *Ceram. Age*, **30** [4] 120 (1937).—A classified list of terms and definitions used in the enameling industry is presented. F.G.H.

Test for acid resistance of porcelain enamels. ANON. *Porcelain Enamel Inst. Bull.*, 9 pp.; reviewed in *Ceram. Age*, **30** [4] 119 (1937).—The tentative standard for this test as developed by the Technical Research Section of the Institute is divided into (1) room temperature test, (2) boiling test, and (3) classification of enamel frits. F.G.H.

PATENT

Building construction. H. L. BROOKS AND H. F. MACINTYRE (Ferro Enameling Co.). U. S. 2,106,315, Jan. 25, 1938 (June 24, 1936).

Glass

Behavior of saltpeter and arsenic trioxide when heating glass melts. M. A. BEZBORODOV, N. D. ZAVYALOV, T. A. LADE, AND G. M. MINKIN. *Zhur. Priklad. Khim.*, **10**, 1407–20 (1937).—The behavior of sodium nitrate and arsenic trioxide was investigated separately and jointly in a melt consisting of sodium carbonate, calcium carbonate, and silica (and in one case also of glass cullet). Curves of the decrease of weight of different charges at 100° to 600°C were plotted. Curves were also plotted for mixes of arsenic trioxide with sodium carbonate or with sodium nitrate. The curves were checked by chemical analyses. P.B. & E.S.

Behavior of tank brick at the glass surface during dissolving. K. O. HAHNEL. Translated in *Glass*, **14** [10] 408 (1937); see *Ceram. Abs.*, **17** [2] 60 (1938). M.C.S.

Causes and effects of strain in glass. NIUTA KLEIN. *Rev. Optique*, **15** [9] 281–97 (1936).—Strain is nearly always the result of stresses produced by viscosity differences during cooling and is accompanied by the simultaneous presence of two allotropic forms: α, stable when cold, and β, stable when hot. The relative proportions of the two forms are determined by temperature and pressure. An unstable glass in which the physical constants vary rapidly, depending on slight variations in temperature and pressure, may be obtained by excessively rapid cooling. F.P.P.

Chemical composition and water solubility of glasses: V. SHOICHIRO NAGAI AND SHUMPEI NAGAEDA. *Jour. Japan. Ceram. Assn.*, **45** [533] 299–312 (1937).—The effect of chemical composition and heat treatment of glass on its solubility in water was studied. (*1*) *Soda-potash-lime glasses.* Soda of a standard soda-lime glass containing 15 soda, 13 lime, and 72% silica was partially or entirely replaced by potash; the solubilities of five glasses in the series were compared by ordinary and autoclave methods. The minimum solubility was shown by the glass containing equimolecular amounts of soda and potash. A heat treatment for 8 hr. at 200°C increased the solubility, and the composition of the minimum solubility was displaced to the glass containing 3 mol. potash to each 1 mol. soda. (*2*) *Chemical glasses.* Similar tests were made on chemical glassware. Beaker glass was the most unstable. A heating at 550° for 45 min. and subsequent slow cooling improved the durability of the glasses. Combustion-tube glass was the most resistant even at high steam pressures. (*3*) *French Securit and Japanese and Czechoslovak safety glasses.* The solubility of polished plate glasses quenched from 550° seems to exceed slightly that of untreated

glasses. For Parts III–IV see *Ceram. Abs.*, **16** [3] 85 (1937); for Parts I–II see *ibid.*, [7] 201. S.K.

Construction of direct daylight factor diagrams with allowance for transmission losses through glass. A. C. STEVENSON. *Jour. Sci. Instruments*, **14** [7] 231–47 (1937).—Usual daylight factor diagrams for predetermination of illumination reaching a point through given window openings assume a uniform and perfectly diffusing sky surface and unglazed windows or the equivalent assumption of a window of uniform brightness. Since the intensity of transmitted luminous flux varies with the angle of incidence because of absorption and multiple reflection, a window can not always be regarded as uniformly bright. Direct daylight factor, therefore, depends in a complicated manner on the transmission factor of the glass, its thickness, and the index of refraction as well as on its shape and position. S. obtains results for the illumination within very close limits, taking into consideration only the index of refraction. He explains his calculations and reproduces his calculating diagrams. Curves comparing direct daylight factors for glazed and unglazed windows are given. J.L.G.

Contamination of glass by grease. ROGER MÉRIGROUX. *Rev. Optique*, **16** [9] 281–96 (1937).—Thorough investigation showed that the chemical action of sulfuric acid plays the essential rôle in final protection of glass against all types of contamination. Thermal treatment consisting of heating to 400°C followed by slow cooling (2 to 3 hr.) completes the action. Other conditions to be avoided are handling of glass with the bare fingers, the presence of oil on the optical instruments, and excessively humid atmospheres. F.P.P.

Critical examination of the standard test for the chemical durability of glass bottles. A. COUSEN. *Jour. Soc. Glass Tech.*, **20** [81] 418–27 (1936).—A test for the durability of 4-oz. medicine bottles is described. It consists essentially in determining the amount of alkali extracted from the inner surface in 5 hr. by using boiling water. The test appears to lose much of its usefulness because of wide variations in results due to different methods of annealing. Other causes of variability are discussed. C.J.P.

Determining the thermal endurance of glass (general methods). H. SCHÖNBORN. *Jour. Soc. Glass Tech.*, **20** [81] 475–97 (1936).—Experiments on glass rods show increased thermal endurance as the rod diameter decreases. A distinction is made between "technical thermal endurance," where the first cracks appear, and "true thermal endurance," where the first transverse cracks occur. The latter is slightly the higher and shows a narrower spread of results. Fire-polishing the ends of annealed rods did not greatly affect the results. The coefficient of expansion alone gave a fairly reliable indication of thermal endurance. An interesting method of measuring thermal endurance is described, wherein the temperature difference remains constant but the test is repeated until failure occurs. 23 references. C.J.P.

Dielectric losses in inorganic glasses at radio frequencies. N. BOGORODITSKIĬ AND I. FRIEDBERG. *Tech. Phys. U.S.S.R.*, **4** [9] 707–16 (1937).—The glasses having lowest dielectric losses are nonalkaline and are characterized principally by structural losses. Glasses containing considerable amounts of heavy oxides and small amounts of alkali approach the nonalkaline glasses but at higher temperatures show ohmic losses. Glasses containing potassium oxide have greater losses, and these are further increased by the addition of sodium oxide, the latter showing ohmic losses at relatively low temperatures. The glasses used contained from 57 to 81% SiO_2 and were all commercial products. See *Ceram. Abs.*, **16** [10] 297 (1937). C.J.P.

Dilatometric investigation of the tempering and annealing of glass of boron anhydride. E. RENCKER. *Compt. Rend.*, **205** [21] 980–81 (1937).—As this glass has never been observed to devitrify, a thermal investigation of its expansion was made. Between 207° and 260°C, hysteresis was found, *i.e.*, complete expansion or contraction does not follow a change in temperature immediately; the time required to reach a stationary volume increases with decreasing temperature. Below 207°, the hysteresis becomes simply a delay in contraction, but only for a glass that has been annealed above 207°. M.H.

Effect of heating bath liquid on thermal durability of glasses. H. SCHÖNBORN. Translated in *Glass*, **14** [8] 334 (1937); see *Ceram. Abs.*, **17** [2] 61 (1938). M.C.S.

Five centuries of glass: I, The Franz Ruhmann collection at Vienna. WOLFGANG BORN. *Connoisseur*, **101** [437] 10–14 (1938).—In this collection are historical examples of glass from the 13th Century to the 18th Century, showing, in the Syrian and Venetian pieces, the derivation of the German glass of the Renaissance. Most of the German gothic glasses are barrel-shaped, greenish colored, and decorated with drawn-out pads of glass from which they were called Warzengläser. They were used as reliquaries, and the seals of the ecclesiastical authorities of the times were dated. The Fichtelgebirgsglas of the 17th Century are of a little-noticed but highly interesting undercurrent of peasant art contemporary with the Renaissance, baroque, and rococo styles. A covered tankard (1601–67) made by Georg Schwanhardt the elder of Nuremberg is the earliest example of the technique of cutting and engraving glass. Illustrated. M.E.P.

Glass and aluminum. J. BALLY. *Rev. aluminium*, **14**, 659–64 (1937); abstracted in *Chem. Zentr.*, **1937**, ii, 3362. —Glass and aluminum are similar in regard to density and specific heat, and both materials have a wide interval of solidification. Because of such characteristics, attempts were made to combine both materials. By spraying aluminum on preheated glass surfaces according to Schoop's method, it is possible to obtain glass with a well-adhering aluminum layer. Practical applications are described. See "Use—," *Ceram. Abs.*, **17** [1] 15 (1938). M.V.C.

Glass defects and their removal in Fourcault glass. ERNST FISCHER. Translated in *Glass*, **14** [11] 455 (1937); see *Ceram. Abs.*, **17** [2] 63 (1938). M.C.S.

Glass ductility and parison distribution. GEORGE ROESSLER. *Glass Ind.*, **18** [7] 230–32 (1937).—By "ductility" is meant the peculiar characteristic of molten glass by which it stretches, bends, and otherwise lends itself to the taking of impressions of the cavity of the mold. The ability of the glass to retain its shape after it has been formed is related to and dependent upon the lack of this ductility. The specific and ultimate functions of the mold, therefore, are (1) to provide a cavity which is precise

as to size, shape, and figurements and (2) to remove the ductility from the hot glass by lowering the temperature. R. gives a résumé of a new theory regarding ductility, showing how the cooling of the glass immediately adjacent to the iron mold surface and the consequent heating up of the iron to an equalized temperature is the basic theory underlying all ductility considerations. Citing various examples to illustrate what is termed "penetration of temperature reduction" in the mold, R. shows how the principle is governed by the factor of control of the intensity of heat-absorbing qualities of the iron. E.J.V.

Glass lime. Basic Dolomite, Inc. *Chem. Industries*, **39** [3] 261 (1936).—A free-flowing dead-burned dolomitic lime having a density approximately that of sand is being manufactured as a glass raw material. It eliminates losses from air slaking and the hazard to workmen resulting from the use of free lime. P.G.H.

Glass melts from alkali-lime-magnesia-alumina-boric oxide-silica mixtures. C. W. Parmelee, A. E. Badger, and W. S. Debenham. *Glass Ind.*, **18** [7] 233–35 (1937). A study of some of the glass melts which result when mixtures of the alkalis, calcia, magnesia, alumina, boric oxide, and silica are heated to a temperature of 1450°C was made. Field A consisted of 49 glass compositions containing 50, 60, 70, or 80% SiO_2, with lime and magnesia added in the weight relationship of 7 CaO to 2 MgO, and the alkalis and alumina added in molecular proportions of $1Na_2O : 1K_2O : 2Al_2O_3$. Field B consisted of 106 glasses in which the silica was maintained constant at 60%, the variables being the alkalis, calcia, magnesia, alumina, and boric oxide. A preliminary determination of resistance to thermal shock of the glasses was also made. E.J.V.

Glass mosaics. Heaton, Butler, and Bayne. *Chem. Industries*, **39** [5] 483 (1936).—Small pieces of colored glass cut to the requisite size for making the design are placed on a sheet of plain glass and fused into a homogeneous whole by the application of heat. P.G.H.

Glasses containing iron oxides: XIII. Kitsuzo Fuwa. *Jour. Japan. Ceram. Assn.*, **45** [532] 213–19 (1937).—F. studied the dissociation of ferric oxide or the percentage ratio of ferrous oxide to total iron oxides, ray transmission, and color of glasses prepared from batches whose lime had been partially replaced by ferric oxide or ferrous oxalate with the following results: (1) In the ferric oxide glasses the greater the total iron content, the lesser is the dissociation, while in the oxalate glasses the greater the total iron content, the greater is the dissociation. Both changes of dissociation fade gradually, however, and the percentage ratios are almost constant for glasses containing about 4% or more of total iron oxides. (2) As long as the total iron content is small, there is no appreciable distinction between the total transmissions of the ferric oxide glasses and the oxalate glasses. With the increase of total iron content, the total transmission of the former glasses takes higher values than that of the latter; the effect is most remarkable in potash glasses, moderate in lithia glasses, and least in soda glasses. (3) The minimum wave-lengths transmitting the oxalate glasses are shorter than those of the ferric oxide glasses as long as the total iron content is small. With higher iron contents the condition is reversed. For Part X see *Ceram. Abs.*, **16** [10] 298 (1937); for Part IV see *ibid.*, **17** [2] 63 (1938). S.K.

Heat losses through walls of glass furnaces of the hearth type. P. de Groote. *Chaleur & Ind.*, **18**, 91–94 (1937); *Brit. Chem. Abs.-B*, **56**, 1203 (1937).—Heat losses from the furnace by radiation, convection, and conduction can not be directly measured or calculated but may be deduced from the difference between the heat content of the fuel and the flue-gas losses. A calculation is made of the heat necessary for production of a given quantity of glass of specified composition. By studying the operation of six furnaces, the heat loss was computed at 30 to 40%.

Influence of specimen width on the breaking strength of sheet glass. A. Smekal. *Jour. Soc. Glass Tech.*, **20** [81] 449–53 (1936).—A logarithmic equation is proposed to express the results obtained by Holland and Turner ("Breaking—," *Ceram. Abs.*, **17** [1] 11 (1938)) on the variation of the transverse strength of sheet-glass strips of different widths. C.J.P.

Infra-red spectrum and structure of silicates and glasses. F. Matossi. *Z. Tech. Physik*, **18** [12] 585–88 (1937).—The infra-red reflection spectra of glasses and silicates are, between 3 and 20μ, very similar. The SiO_4 group appears in both glass and silica spectra. The position of maxima of reflection depends on the composition of the glass. Experiments with pure silica glass seem to indicate that small crystals are present in glass. W.M.C.

Law of annealing of glass—quantitative treatment and molecular interpretation. Nelson W. Taylor. *Jour. Amer. Ceram. Soc.*, **21** [3] 85–89 (1938).

Modern glass technology: I. Anon. *Glass*, **14** [8] 341 (1937).—Typical batches, furnace types, and methods of fabricating glass articles are dealt with. M.C.S.

Nepheline syenite. R. B. Ladoo. *Glass Ind.*, **18** [6] 204–206 (1937).—Nepheline syenite, a source of alumina for the glass industry, is a rock of high alumina content and contains the minerals nepheline (or nephelite) mixed with potash and soda feldspars. Nepheline is a sodium aluminum silicate which always contains, in the natural mineral, a certain amount of potash; it has been given the formula $K_2O \cdot 3Na_2O \cdot 4Al_2O_3 \cdot 9SiO_2$. It is closely analogous to the potash and soda feldspars in composition and properties but differs from them in the relative percentages of alumina, silica, and alkalis and in the soda-potash ratio. Commercial working and preparation of nepheline syenite from Blue Mt., Methuen Township, Ontario, Canada, are described in detail. Nepheline syenite is primarily a self-fluxing source of alumina in glassmaking, *i.e.*, it contains enough soda and potash to be readily fusible without the addition of other ingredients. Beneficial results have been reported. E.J.V.

Noble metals coat glass only atom thick. Anon. *Science News Letter*, **32** [856] 153 (1937).—Plates of glass, enamel, and quartz can be coated with atom-thick layers of gold, silver, platinum, and other precious metals so that neither mechanical, electrical, nor chemical forces will strip them off. A layer of nickel is deposited by cathodic dispersion and then a layer of noble metal by the same method. P.G.H.

Optical Glass Works at Benediktbeuren (Germany). W. H. Chance. *Proc. Phys. Soc.* [London], **49**, 433–43 (1937).—Optical glass has been manufactured since 1733, when Hall discovered the achromatic lens. In 1804 the

Mathematical-Mechanical Institute Reichenbach, Utzschneider, & Liebherr began making optical instruments in Bavaria. The glassworks were at Benediktbeuren. In 1811 Joseph Frauenhofer was put in charge of the works. He not only supervised the glassmaking (crown glass) but was also engaged in the following years upon fundamental work, *viz.*, accurate measuring of the refractive index and dispersion of the meltings made. He developed methods of testing glass durability with sulfuric and nitric acids. Polished surfaces were treated with such acids (H_2SO_4). By 1824 Frauenhofer was principal owner of the Benediktbeuren Works. He completed the great Dorpat reflector in 1824 (9½-in. aperture). The glass works at Benediktbeuren were abandoned in 1884. Illustrated. L.E.T.

Permeability of Plexi glass for ultra-violet light. T. JAKOBSON. *Tek. Tid., Uppl. C*, **67** [7] 15–16 (1937); abstracted in *Physik. Ber.*, **18** [22] 2250 (1937).—Noncolored Plexi glass transmits more than 40% of the light of the Cu arc in the long-wave range up to 2168 Å and about 20% at 2350Å. Blue-colored Plexi glass absorbs all light beginning at 2800Å. Noncolored and weakly colored Plexi glass is therefore superior to window glass for ultraviolet permeability. M.H.

Permeability of some materials for thermic rays. V. P. KISSLOV. *Zhur. Tekh. Fiz.*, **6**, 837 (1936); abstracted in *Chem. Zentr.*, **1937, i**, 2430; *Ceram. Age*, **30** [2] 47 (1937). The total permeability of vertically ascertainable thermal rays from a black body at 100°C was investigated on various types of window glasses, mica, celluloid, and cellulose films. All of these materials proved permeable even at thicknesses of 1 to 2 mm. for at least some of the rays (1 to 5% or less). A decrease in the permeability was noticed with a thickness of 0.1 mm. in glass, ethyl cellulose, mica, celluloid, and benzyl and acetyl cellulose. At a thickness above 0.7 mm., mica proved considerably more permeable than glass and the cellulose derivatives. The composition of glass does not seem to affect permeability to a notable degree. Permeability is not restricted to the short waves of the radiation employed (up to 8 mm.) but extends to the longer waves as well, though to a somewhat lesser degree. Acetyl cellulose and celluloid of 0.10- to 0.14-mm. thickness retain from 89 to 92% of the thermal rays; thus these may serve as substitutes for glass, wherever increased heat penetration is to be avoided. F.G.H.

Production of aluminum mirrors by evaporating the metal in vacuum. H. DAMBIER. *Rev. aluminium*, **14**, 665–68 (1937); abstracted in *Chem. Zentr.*, **1937, ii**, 3361–62.—After a short discussion of processes occurring during the evaporation of metals in vacuum, D. explains how this method can be applied to the manufacture of aluminum mirrors. See "Mirrors—," *Ceram. Abs.*, **15** [6] 176 (1936). M.V.C.

Proposed standard thermal-endurance test based on the use of glass rods. GLASS STANDARDS COMMITTEE OF THE SOCIETY OF GLASS TECHNOLOGY. *Jour. Soc. Glass Tech.*, **20** [81] 498–510 (1936).—Experiments were performed by six laboratories on various glasses in the form of rods 5 cm. long and 2 to 6 mm. in diameter. These were heated in an electric furnace and chilled in water. The results encouraged the hope that a general test can be formulated. C.J.P.

Small electric furnaces in the glass industry. A. BUCH. *Elektrowärme*, **7** [12] 262–63 (1937).—While electric furnaces are not yet extensively used for the actual melting process, they are employed for firing colors, cooling, reheating, heating of presses and dies, etc. Advantages of electric heating over other fuels are discussed briefly. M.H.

Spectrographic studies on ancient glass. Chinese glass from pre-Han to T'ang times. P. D. RITCHIE. *Tech. Studies Field Fine Arts*, **5**, 209–20 (1937); *Brit. Chem. Abs.–B*, **56**, 911 (1937).—Following a historical review of the antiquity and composition of Chinese glass, R. tabulates and discusses data for spectrographically discovered elements in 45 specimen objects. See *Ceram. Abs.*, **16** [4] 107 (1937).

Suggested standards for testing safety glass. FRITZ VERSEN. *Jour. Soc. Glass Tech.*, **20** [81] 454–60 (1936).—V. describes tests for manufacturing control of laminated and toughened glass intended for motor-car windows, windshields, goggles, etc. C.J.P.

Technical boric oxide glasses. OSCAR KNAPP. Translated in *Glass*, **14** [9] 368 (1937); see *Ceram. Abs.*, **17** [2] 66 (1938). M.C.S.

Thermal endurance of glass. W. M. HAMPTON. *Jour. Soc. Glass Tech.*, **20** [81] 461–74 (1936).—Thermal endurance is defined as "the sudden drop of surface temperature of a glass article at which the probability of fracture is equal to the probability of survival." A part of the existing literature is reviewed, and the measure of agreement between observation and calculation is critically discussed. H. shows that thermal endurance depends on at least seven factors: (1) composition, (2) state of annealing, (3) shape, (4) thickness, (5) cooling medium, (6) method of chilling, and (7) state of the glass surface. As a standard method, he suggests that carefully handled, well-annealed rods or beakers be heated in a gas or electric oven and chilled in water. 21 references. C.J.P.

Thermal endurance of glass. KOZO TABATA AND TARO MORIYA. *Jour. Soc. Glass Tech.*, **20** [81] 524–29 (1936); *Jour. Japan. Ceram. Assn.*, **45** [534] 387–90 (1937).—The effect of the composition of mixed alkali-boric oxide-silica glasses on their thermal endurance was investigated. The compositions were (*A*) $xK_2O\cdot(1-x)Na_2O\cdot 0.5$ to $3B_2O_3\cdot 2x+$(6 to 14)SiO_2 and (*B*) $xK_2O\cdot(1-x)Na_2O\cdot zB_2O_3\cdot 4z+$(4 to 6) SiO_2, x and z varying from 0 to 1 and 0.5 to 3, respectively. Test pieces were well-annealed round rods, 5 mm. wide and 30 mm. long, with fire-polished ends. They were heated at constant temperature for more than 20 min. and dropped in water of room temperature. Critical thermal shock or the minimum temperature difference required for breakage was determined by finding a temperature difference such that 1 of 2 rods tested at the same time is cracked while the other is sound. It is concluded that the relation between thermal endurance and chemical composition makes an approximately parabolic surface. It is illustrated by a solid model. In (*A*) formulas, the relation is parabolic, *e.g.*, in $xK_2O\cdot(1-x)Na_2O\cdot 0.5B_2O_3\cdot 2x+6SiO_2$, the minimum temperature differences are 149°C for $x=0$, 177° for $x=0.25$, 143° for $x=0.5$, 157° for $x=0.75$, and 198° for $x=1$. The relation is about rectilinear in (*B*) formulas. C.J.P. + S.K.

Thermal endurance of glass articles. R. W. DOUGLAS.

Jour. Soc. Glass Tech., **20** [81] 517–23 (1936).—D. describes a case where the usual thermal-endurance test on glass tubing did not give results in agreement with its service behavior. An alternative test found to be satisfactory is described. This test necessitated heating the tubing and then forcing cold mercury up the bore. The previous anomalous results were explained by differences in the tensile strength of the inner and outer surfaces. C.J.P.

Thermal-endurance tests for glassware. J. B. MURGATROYD. *Jour. Soc. Glass Tech.*, **20** [81] 511–16 (1936).—M. points out that there is no essential difference between a temperature "shock" and a straight-line temperature gradient through the glass thickness. The latter is claimed to be more accurate, and a simple test of this kind, for hollow ware, is described. C.J.P.

Tinted windows to kill sun glare. TRUSCON LABORATORIES. *Chem. Industries*, **39** [2] 149 (1936).—Opaltone for tinting window glass to kill glare and still admit more than 90% of the daylight is announced in two forms. One form is permanent and durable for brushing or spraying on the inside or outside of window glass, and the other is a removable coating for use on the inside. Both are furnished in either blue tint or white. Room temperatures are reduced as much as 10° to 15° through the use of Opaltone. P.G.H.

Use of Gehlhoff and Thomas specific effect data in practice. ANON. *Glass Ind.*, **18** [7] 227–29 (1937).—The extensive work conducted by Gehlhoff and Thomas (*Ceram. Abs.*, **5** [11] 353 (1926)) on the effect of various glass-forming oxides on the physical and mechanical properties of glass is the most systematic investigation on this subject in recent glass literature. While their method does not give all the information required (it takes into account neither the effect of combinations of the various oxides nor the effect of variations in the soda content), it does indicate the effect of the replacement of part of the silica by other oxides, a procedure often followed when changing formulas. These data are strictly applicable only to glasses which approach the parent glass in composition, but they can indicate general results which may be expected. E.J.V.

BOOKLET

Feldspar as a constituent of glass. ANON. *Nat. Feldspar Assn. Booklet*, 78 pp.; reviewed in *Ceram. Age*, **30** [4] 119 (1937).—The testing of feldspar and the effect of feldspar on the devitrification, mechanical properties, and chemical durability of glass are described in detail. Glass compositions are discussed thoroughly, and factors are given for use in glass composition calculations. See *Ceram. Abs.*, **15** [11] 345 (1936). F.G.H.

PATENTS

Apparatus for cooling glass for tempering. SOC. ANON. DES MANUFACTURES DES GLACES & PRODUITS CHIMIQUES DE ST. GOBAIN, CHAUNY & CIREY. Brit. 477,156, Jan. 7, 1938 (June 21, 1935).

Apparatus for forming glassware. R. W. CANFIELD AND THOMAS WAUGH (Hartford-Empire Co.). U. S. 2,106,546, Jan. 25, 1938 (Feb. 14, 1935). Apparatus for making hollow glassware is described.

Apparatus for making sheet glass. H. L. HALBACH (Pittsburgh Plate Glass Co.). U. S. 2,106,890, Feb. 1, 1938 (Dec. 24, 1935).

Apparatus for tempering glass articles. CORNING GLASS WORKS. Brit. 477,414, Jan. 12, 1938 (Sept. 24, 1935).

Borosilicate glasses highly resistant to alkaline liquids and method of making. JENAER GLASWERK SCHOTT & GEN. Brit. 477,698, Jan. 19, 1938 (July 22, 1935).

Chilling baths for tempering glass. CORNING GLASS WORKS. Brit. 477,593, Jan. 12, 1938 (Sept. 24, 1935).

Closures of glass jars, etc. DEWEY & ALMY, LTD. (Dewey & Almy Chemical Co.). Brit. 477,210, Jan. 7, 1938 (April 23, 1936).

Coating glass sheets with polymerized vinyl compounds. D. C. POLDEN AND E. W. ALDRIDGE. Brit. 478,163, Jan. 26, 1938 (March 31, 1937).

Coffee makers. CORNING GLASS WORKS. Brit. 477,203, Jan. 7, 1938 (Aug. 17, 1936).

Colored or decorative glass and method of producing. F. D. PARKINSON. Brit. 478,301, Jan. 26, 1938 (July 13, 1936).

Double window construction. WILLIAM OWEN (Pittsburgh Plate Glass Co.). U. S. 2,106,900, Feb. 1, 1938 (April 27, 1937).

Drift-controlling apparatus for glassware annealing leers. D. G. MERRILL (Hartford-Empire Co.). U. S. 2,106,678, Jan. 25, 1938 (March 2, 1937).

Glass-feeding apparatus. L. G. BATES (Hartford-Empire Co.). U. S. 2,106,545, Jan. 25, 1938 (April 29, 1936).

Glassmelting furnace. R. W. CANFIELD (Hartford-Empire Co.). U. S. 2,106,547, Jan. 25, 1938 (Sept. 12, 1936).

Glass-to-metal seals. STANDARD TELEPHONES & CABLES, LTD. Brit. 477,728, Jan. 19, 1938 (Feb. 4, 1936).

Glass-tempering apparatus. J. L. DRAKE (Libbey-Owens-Ford Glass Co.). Can. 371,150, Jan. 11, 1938 (Dec. 30, 1936). GERALD WHITE (American Securit Co.). Can. 370,968, Jan. 4, 1938 (Feb. 15, 1937; in U. S., Feb. 29, 1936). G.M.H.

Hollow glass building block. B. F. HAZELTON, JR. (Owens-Illinois Glass Co.). U. S. 2,107,994, Feb. 8, 1938 (Oct. 11, 1935; renewed July 16, 1937).

Light-diffusing glass. HENRI PAUL. U. S. 2,107,833, Feb. 8, 1938 (Aug. 26, 1935).

Low-expansion annealed glass. H. P. HOOD (Corning Glass Works). U. S. 2,106,526, Jan. 25, 1938 (Feb. 19, 1935; Nov. 22, 1935). An annealed glass article having a minimum thickness of at least 6 in. and composed of a glass having a thermal expansion coefficient not greater than 0.0000030 which will not devitrify when heated for more than 10 days at temperatures in the annealing range of the glass and which consists of silica, boric oxide, alumina, and alkali, the silica content being between 75 and 87%, the alumina being between 0.1 and 1.0% as shown by analysis, and the total alkali content being between 0.5 and 2.5%.

Machine for making hollow glassware. T. C. MOORSHEAD AND E. P. DORMAN (Ball Brothers Co.). U. S. 2,107,011, Feb. 1, 1938 (Aug. 15, 1933).

Machine for the manufacture of ampullas, etc. J. DICHTER. Brit. 477,552, Jan. 12, 1938 (July 5, 1935).

Making hollow glassware. T. H. SLOAN (G. M. S. Corp.). U. S. 2,106,193, Jan. 25, 1938 (Nov. 30, 1935).

Making safety glass. J. H. SHERTS AND B. J. DENNISON (Duplate Corp.). U. S. 2,106,766, Feb. 1, 1938 (Dec. 22, 1934). A process of making safety glass consists in applying a layer of plasticized resin in powder form to a glass plate, heating the layer and pressing it onto the plate so that the particles adhere to each other and to the plate but without colloiding, assembling a second glass plate on the first plate with the resin layer therebetween, and subjecting the sandwich thus formed to pressure and to sufficient heat to colloid the layer into a solid transparent sheet tightly adherent to the glass sheets.

Making tempered articles of lime-soda glass. CORNING GLASS WORKS. Brit. 477,460, Jan. 12, 1938 (July 1, 1935).

Manufacture of compound glass and other laminated materials. A. ROSENTHAL. Brit. 477,964, Jan. 19, 1938 (July 10, 1936).

Manufacture of tempered-glass articles. CORNING GLASS WORKS. Brit. 477,585, Jan. 12, 1938 (July 31, 1935).

Means for feeding glass to glass-forming machines. T. C. MOORSHEAD (United Glass Bottle Manufacturers, Ltd.). U. S. 2,106,899, Feb. 1, 1938 (Feb. 5, 1936).

Means for feeding glass to glass-shaping machines. T. C. MOORSHEAD (Ball Brothers Co.). U. S. 2,107,012, Feb. 1, 1938 (Jan. 30, 1935).

Method and product for treating glass wool. H. M. BONE AND R. C. WILLIAMS (Owens-Illinois Glass Co.). U. S. 2,107,284, Feb. 8, 1938 (Feb. 20, 1936).

Preparation of silica or glass batches. H. P. HOOD (Corning Glass Works). U. S. 2,106,745, Feb. 1, 1938 (March 23, 1936). The method of preparing silica for use in glass batches includes introducing the silica into an acid solution, adding thereto a flotation reagent including a naphthylamine compound, agitating the solution in a flotation apparatus to float off the iron impurities, and drying the silica.

Process and apparatus for manufacturing glass sheets by drawing. SOC. ANON. DES MANUFACTURES DES GLACES & PRODUITS CHIMIQUES DE ST. GOBAIN, CHAUNY & CIREY. Brit. 477,244, Jan. 7, 1938 (March 23, 1936).

Refractory for contacting molten glass. J. C. HOSTETTER (Corning Glass Works). U. S. 2,106,527, Jan. 25, 1938 (June 27, 1936). In the production of glassware, a metal part for contact with molten glass comprises a body of platinum having on that surface which is not in contact with the glass a rhodium-containing casing which is integral with the platinum.

Safety glass. FRIEDRICH MEYER. Can. 371,065, Jan. 4, 1938 (March 24, 1936). G.M.H.

Sheet-glass handling apparatus. J. H. MOLLER (Libbey-Owens-Ford Glass Co.). U. S. 2,106,573, Jan. 25, 1938 (Feb. 20, 1936).

Tempered-glass article. J. B. MITFORD (Pilkington Bros., Ltd.). Can. 371,006, Jan. 4, 1938 (Jan. 2, 1937). G.M.H.

Treated borosilicate glass. H. P. HOOD AND M. E. NORDBERG (Corning Glass Works). U. S. 2,106,744, Feb. 1, 1938 (March 19, 1934). A shaped article of glass made from another glass, the composition of which lies in a limited region of the ternary system $R_2O \cdot B_2O_3 \cdot SiO_2$, the region comprising compositions which will separate by heat treatment into two phases, one of which is easily soluble and the other insoluble, the final glass containing a substantially lesser percentage of boric acid and alkali than the initial glass.

Structural Clay Products

Brick gutters laid in Queens Boulevard. A. K. JOHNSON. *Dependable Highways*, No. 153, p. 3 (1936).—Details of the design and construction of brick gutters laid in the central roadways of Queens Boulevard, Queens Borough, New York, for a distance of three miles are described. Illustrated. P.S.D.

Brick has lowest maintenance. ANON. *Buffalo [N. Y.] Dept. Public Works, 41st Ann. Rept.; Dependable Highways*, No. 151, p. 6 (1936).—Maintenance data have been assembled in tabular form. Maintenance costs of asphalt, block stone, and paving brick are compared. P.S.D.

Brick parking strips in Minneapolis. ANON. *Dependable Highways*, No. 152, p. 9 (1936).—The use of vitrified paving-brick units in the construction of brick parking strips 4 to 6 ft. wide at the curb of certain Minneapolis streets is described. P.S.D.

Brick pavement in Grand Rapids. W. H. HARVIE. *Dependable Highways*, No. 150, pp. 7–8 (1936).—The history and details of construction of the Monroe Ave. (Grand Rapids, Mich.) brick pavement are discussed. P.S.D.

Brick pavements in Baltimore. ANON. *Dependable Highways*, No. 152, pp. 3–8 (1936).—An improvement program for certain Baltimore streets, employing modern vitrified paving-brick units, is outlined. Details of construction are included. Illustrated. P.S.D.

Brick road experiments in Ohio. R. R. LITEHISER. Presented at 15th Ann. Meeting of Highway Research Board, Dec., 1935; abstracted in *Dependable Highways*, No. 150, pp. 3–4 (1936).—Among the several experimental studies of brick-pavement design and construction made in Ohio during recent years, the following are outstanding: (1) the Carroll County experimental brick road built in 1933, and (2) the Hocking County brick filler experiment. The first named project was divided into four general types: (*a*) monolithic, (*b*) semimonolithic, (*c*) grout-filled on granulated slag cushion, and (*d*) bituminous-filled. The monolithic type gave excellent service. The other types showed disadvantages of cracking and opening of joints. Causes of these defects are discussed. In the brick-filler experiment, fillers were selected on the basis of nonexuding qualities and commercial availability. Details regarding the construction of the experimental sections are included. P.S.D.

Correlation of electrical and thermal properties of brick. J. STUART JOHNSON. *Jour. Amer. Ceram. Soc.*, **21** [3] 79–85 (1938).

Design and construction of the modern brick pavement. R. L. PHILLIPS. Presented at Meeting of Amer. Road Builders Assn., 1936; abstracted in *Dependable Highways*, No. 150, pp. 5–6 (1936).—Fundamentals and economies having a direct bearing on the proper design of a modern brick pavement are discussed. The recent laboratory work undertaken by various groups, *e.g.*, the state university laboratories, state highway laboratories, U. S. Bureau of Public Roads, and the National Paving Brick Assn., is decidedly beneficial to a better understanding of the principles of design and construction. P. describes his conception of the best present-day design of a brick pavement. P.S.D.

Developments in pavement design. JULIUS ADLER. Presented at Annual Meeting of Highway Division, Amer. Soc. Civil Engrs., Jan., 1936; abstracted in *Dependable Highways*, No. 150, pp. 9–11 (1936). P.S.D.

Research in brick and brick pavements. H. Z. SCHOFIELD. *Roads & Streets*, **81** [1] 43–45 (1938).—A review of filler materials for brick roads is given. Four fillers are being tried by the Ohio State Highway Dept. in some of its new construction. Brick roads reinforced with $^1/_8$-in. diameter steel running transversely and longitudinally are being tried in both Ohio and Ill. with excellent results. P.G.H.

Scum: causes and cure. EDMUND EVANS. *Clay Prod. Jour. Australia*, **5** [2] 15–17 (1937).—Some of the causes of scum on brick and terra cotta, such as oil, coal, or water, may be removed, but the soluble salts of the clay can not be removed and require special treatment. Barium carbonate is efficient but may prove too expensive. E. explains his method of setting and firing the kiln so that scum does not appear. Face brick is set flat in single pitches with finger room around each brick, leaving a $1^1/_4$-in. space at the ends between the pitches. Every five courses a brick on edge is run across the kiln; the back row is finger-room skintled to act as a stop and prevent rolling in the kiln. This method of setting overcomes the scum in the first stages. The kiln should be fired steadily night and day up to the point of final steaming; otherwise scum deposits. The last 15 hr. up to maximum heat should be fired with alternate charges of coal and green wood (ironbark tree or any other wood rich in volatile constituents, *e.g.*, green English oak). The condensing vapors are adsorbed on the face of the brick, and a glaze is formed equal to a salt glaze which is durable and effective in removing scum. H.H.S.

Some old materials for modern uses. JORDAN A. PUGH. *Bull. Amer. Soc. Testing Materials*, No. 82, pp. 4–5 (1936); reprinted in *Ceram. Age*, **29** [1] 14–15 (1937).—Developments in structural clay products are reviewed. F.G.H.

Strength, water absorption, and resistance to freezing and thawing of sand-lime brick. JOHN W. MCBURNEY AND ALLAN R. EBERLE. *Jour. Research Nat. Bur. Standards*, **20** [1] 67–76 (1938); R.P. 1065. Price 5¢.—The compressive and transverse strengths, water absorption, and penetrability of 120 specimens of sand-lime brick representing 11 plants were determined. Sieve analyses of sands from the same plants were also made. The same brick were subjected to 50 cycles of freezing and thawing. It is concluded that resistance to freezing and thawing of sand-lime brick is estimated by strength when the brick comply with the visual inspection clause of the A.S.T.M. specification for sand-lime brick C73–30. R.A.H.

Testing the wear of road metals and aggregates. A. L. COULSON. *Trans. Mining & Geol. Inst. India*, **31** [3] 227–41 (1937).—Attrition tests on road metals were made in (*a*) Deval, (*b*) Lovegrove, and (*c*) Los Angeles attrition machines. The Los Angeles machine gave results of most value to the road engineer, the attrition tests agreeing closely with the service record of the materials. The tests are made more quickly than with other machines. A.P.S.

PATENTS

Building brick. W. S. GRICE. Brit. 477,445, Jan. 12, 1938 (June 9, 1937).

Building unit and wall. J. W. WARREN. U. S. 2,106,387, Jan. 25, 1938 (Nov. 16, 1933).

Fire-wall construction. GEORGE CROMBIE, SR. (Stearns-Roger Mfg. Co.). U. S. 2,107,524, Feb. 8, 1938 (Feb. 12, 1936).

Machine for roughening brick. DUNCAN WHITEHOUSE. U. S. 2,107,097, Feb. 1, 1938 (Jan. 25, 1937). A machine for roughening the surfaces of brick comprises a frame including a pair of spaced supports having journal bearings therein, a drive shaft mounted in the journal bearings, a roughening tool splined for longitudinal reciprocation on the shaft, coöperating cam means respectively on the supports and tool for causing reciprocation of the tool on the shaft responsive to rotation of the shaft, and conveying means disposed relative to the tool for feeding brick across the tool in contact therewith.

Machine for roughening brick. D. WHITEHOUSE AND MARSTON VALLEY BRICK CO., LTD. Brit. 478,155, Jan. 26, 1938 (Jan. 8, 1937).

Refractories

Action of slag from fuel in boiler furnaces. E. G. BAILEY. *Bull. Amer. Ceram. Soc.*, **17** [2] 55–67 (1938).

Casting-pit refractories. A. MCKENDRICK. *Refrac. Jour.*, **13** [3] 143 (1937).—The development of firebrick and fireclay shapes and specialties with improved life and lower ton cost of steel has been thoroughly studied since 1933. M. discusses in detail the methods undertaken in England in an effort to improve the refractories used in the steel plants there. Ladle brick, nozzles, rod covers, stopper ends, guide tubes, and runner brick are discussed separately and the problems of each set forth. See *Ceram. Abs.*, **16** [8] 246 (1937). M.C.S.

Choosing the right brick for insulated furnace walls. R. S. MOORE. *Ind. Heating*, **5** [1] 69–72 (1938).—Advantages of insulating refractories are briefly explained; two types are made at present, one for use up to 1600°F,

the other up to 2000°F. Specific examples of selecting the brick are given, and the importance of stored heat in the operation of the furnace for the selection is pointed out. M.H.

Conservation of heat by insulation. W. GOLDSBROUGH AND S. G. THROSSELL. *Brit. Steelmaker*, **3**, 295–98 (July, 1937); *Jour. Iron & Steel Inst.* [London], **136** [2] 215A (1937).—A brief mathematical treatment of the problem of heat losses in furnaces is given, followed by an account of practical methods of heat insulation.

Deformation at high temperature of silicoaluminous refractory materials. BERNARD LONG. *Céramique*, **40** [597] 205–10 (1937).—Deformation of refractories under constant charge and constant temperature was studied. This method is similar to experiments used to determine the behavior of metals at high temperatures. The present studies deal chiefly with the effect of porosity and, in this case, the rate of deformation is roughly proportional to porosity. The contraction of pores takes place chiefly during the first hours of the test. Chemical composition also has some effect. Additions of lime increase at 1250°C the apparent viscosity of the initial refractory and change more rapidly the apparent viscosity as a function of temperature. The addition of feldspar does not modify markedly apparent viscosity of the initial refractory between 1250° and 1300°; it moderates the variation as a function of temperature over 1300°. These studies confirm the importance of the vitreous phase and deformation under load at high temperature. The effect of the kind of atmosphere, oxidizing or reducing, was confirmed; deformation is greater in reducing atmosphere than in oxidizing atmosphere. The effects of iron and titanium contents are noticeable. These tests show clearly that refractoriness (a characteristic still badly interpreted) of silicoaluminous refractories is essentially a function of (1) the composition and physical structure of the crystallized phase, (2) the composition and distribution of the vitreous phase, (3) the relative properties of these two phases, and (4) the importance and nature of porosity. See "Method —," *Ceram. Abs.*, **15** [1] 23 (1936). M.V.C.

Firestone as a refractory. HARRY RAYNER. *Blast Furnace & Steel Plant*, **25** [9] 1009–12 (1937).—Firestone is a silica rock naturally cemented and hardened by enormous pressure and chemical agencies for ages. Due to a combination of its peculiar granular structure and chemical analysis, coupled with colloidal silica bond, it has great resistance to combined fire and abrasion. The grade known as "split rock," having cleavage in straight and parallel lines, has the following properties: freedom from contamination with lime or other alkali which would act as a fluxing agent; 93% SiO_2 and about 4% Al_2O_3 content; crushing strength 8 to 10 thousand lb./sq. in.; modulus of rupture 675 to 850 lb.; fusion point 3000°F; and weight 133 to 140 lb./cu. ft. If allowance for the greater expansion above 1100°F is made, it is suitable for lining cupolas, ladles, and soaking pits and is more economical than refractory brick. E.J.V.

Hydraulic refractories and development. J. G. COUTANT. *Blast Furnace & Steel Plant*, **25** [10] 1142–44 (1937).—Using *ciment fondu* (high aluminous fused hydraulic cement) with the proper kinds of refractory grog in correctly mixed batches, it is possible to produce insulating refractories and high-refractory material. Methods of testing and results obtained by two European laboratories are given. E.J.V.

Influence of conductivity on internal heating of a refractory and its effect on its pyrometric resistance. P. BREMOND. *Chaleur & Ind.*, **18**, 81–83 (1937); *Brit. Chem. Abs.–B*, **56**, 1206 (1937).—A cube of SiO_2, graphite, or $SiO_2 \cdot Al_2O_3$ was heated in the range 1100° to 1400° in a high-frequency electric furnace, and the temperature was raised at the rate of 100° or 300°/hr. Thermocouples were placed at the inside and outside of the cube. At the higher rate of heating the average temperature difference between the inside and outside of the specimen was appreciable (29° for SiO_2); at the lower rate it was less than 10° in all three cases.

Italian firebrick industry. G. VERZOCCHI. *Refrac. Jour.*, **13** [4] 211 (1937).—The manufacture of refractories in Italy dates from about 1914. Prior to the World War most of the refractories used in Italy were imported, but with the start of the war it became necessary to manufacture their own. Since that time the deposits of refractory materials located in Italy have been studied, and ways and means of incorporating them into refractory units have been developed. The highest-grade refractories produced at the present time are not composed wholly of native raw materials, a portion of the ingredients necessarily being imported. M.C.S.

Mechanically supported refractories for industrial heating furnaces. ANON. *Ind. Heating*, **4** [10] 912–22; [11] 1007–10; [12] 1103–1108 (1937).—An exhaustive survey is made. Refractory shapes used in the different parts of furnaces, their construction, the method of holding them in place, air-cooled walls, and arch construction are described. M.H.

Methods of testing refractory materials: III, Temperature of incipient softening according to the methods of the C.T.I. and the DIN. L. BELLADEN. *Metallurgia Ital.*, **29** [2] 55–57 (1937).—Although the definitions of the temperature of incipient softening of refractory materials proposed by the C.T.I. (Italian) and the DIN (German) are substantially the same, the Italian method gives results much lower than the German. Both methods are analyzed; the German equipment introduces sources of error not present in the Italian. F.P.P.

Production of chromite and magnesite refractories in Italy. L. POMPEI. *Metallurgia Ital.*, **29** [8] 408–10 (1937).—P. concludes that Italian production of chromite, magnesite, and chrome-magnesite refractories could, if properly controlled, replace importation of similar foreign products. F.P.P.

Reanalysis of refractory heat loss on basis of heat capacity. J. G. COUTANT. *Blast Furnace & Steel Plant*, **25** [4] 440–41 (1937).—The development of insulating refractories and refractory "block" insulation for keeping high-temperature heat in furnaces has led to a closer study of heat loss on the basis of heat capacity. Due to the insulation, it is possible to make walls thinner and of lighter material. These have a low heat capacity which eliminates most of the lag in heat flow through the furnace and greater insulating properties which reduce some of the radiation loss. More heat is available at the desired moment and the heat head over the hearth or bath is

doubled. Data on heat balances to prove this point are presented. See "Economic—," *Ceram. Abs.*, **16** [1] 21 (1937). E.J.V.

Refractories. ANON. *Times Trade & Eng.*, **42** [887] xix (1938).—A brief summary is given of advances in the technique and manufacture of refractory materials with special reference to sillimanite, silicon carbide, spinels, olivines, hot-face insulation, fused silica, fused alumina, and cast refractories. Refractory cements and refractory concrete are also mentioned. A.B.S.

Refractories application—the trend in the steel plant. A. V. LEUN. *Iron & Steel Engr.*, **14** [3] 36–46 (1937).—Improvements made in the manufacture and application of refractories for the steel industry were necessitated because of (1) greater service and temperature imposed on the refractories in the making of steel; (2) continued drive for cleaner steel; (3) necessity for lower refractories cost; (4) necessity for lower fuel consumption per ton of steel produced. Ladle refractories were made with higher vitrification temperatures, higher fusion points, and lower porosity to meet hotter and longer pouring practice. Stopper heads had to be made with lower heat conductivity to prevent burning off bolts. Insulation of open-hearth furnaces has not only resulted in fuel savings, but silica brick in the roofs are better seasoned, and insulated roof brick show zones of cristobalite and tridymite, while the uninsulated roof brick show four zones. Unfired magnesite and chrome brick made under pressures as high as 10,000 lb./sq. in. have greater density than ordinary fired brick, giving them better resistance to slag erosion and spalling. Lightweight insulating refractory brick are especially adaptable to those furnaces whose operation is intermittent. Semisuper refractory clay brick made with little or no fusing bond clay gave longer life and helped prevent refractory inclusions in the steel. De-aired fireclay brick resulted in greater efficiency for regenerator service, due to better and more uniform firing and increased density. Power-pressed silica brick free from warps eliminate much of the snapping off common to drop- or hand-rammed brick. E.J.V.

Refractories for gas retorts. ANON. *Engineering*, **139** [3599] 15–16 (1935).—The capital cost of producing 500 million cu. ft. of gas per annum is approximately £140,000; of this sum, 20 to 25% is the cost of the refractories, including setting used in the carbonizing installation. Higher temperatures, more rapid carbonization, and discharging to schedule make increased demands upon refractories. With horizontal settings, the working life varies from 1000 to 2500 days; vertical settings show even wider variation. Horizontal settings are damaged by spalling, bad design of the setting, faulty joints, and machines used in charging and discharging. The slagging action of the dust-carrying producer gas may also be a contributing cause of failure. In vertical retorts, the presence of vertical joints in which the jointing clay does not hold firmly may be a cause of failure as well as those given above. The 25th report of the British Refractories Research Association (*Ceram. Abs.*, **14** [11] 278–82 (1935))is referred to and commended. H.E.S.

Refractories for the steel industry. L. J. TROSTEL. *Iron & Steel Engr.*, **14** [3] 24–35 (1937).—Improved refractories of today are the result of a better understanding of the properties of raw materials and the reduction to practice of methods of developing and controlling them. The life of refractories has been improved due to physico-chemical considerations of properties of refractories dependent on composition and close scrutiny of the mechanics of certain physical properties which result largely from processing. The unit operations for processing refractories have been modernized. Improved refractories available for steelmaking are improved basic brick of high resistance to spalling and low thermal conductivity; crystalline base refractories from kyanite of high density and spalling resistance; super-duty fireclay brick exhibiting negligible volume change at high temperatures and of unusual resistance to spalling; general improvement in ordinary first-quality fireclay brick; and insulating brick of high refractoriness. Applications of improved refractories in furnace construction are listed. E.J.V.

Refractories in the steel plant. J. SPOTTS MCDOWELL. *Blast Furnace & Steel Plant*, **26** [1] 72–74 (1938).—Recent improvements in the manufacture of chemically bonded magnesite brick have resulted in increased strength, density, and stability of volume at high temperatures. They have found considerable application in open-hearth furnaces for back, front, bridge, and end walls (bulkheads). In rotary kilns for firing refractory dolomite and magnesite, chemically bonded magnesite brick have proved superior to high-alumina brick for lining the firing zone. By careful selection of olivines for use in making forsterite brick, greater amounts of forsterite, with improved properties, are developed in the fired refractory. Magnesite-bonded chrome brick of greatly improved quality, especially regarding resistance to spalling and load-carrying capacity at high temperatures, have been developed. Super-duty fireclay brick, with excellent resistance to spalling, low porosity, low permeability to slags and gases, and unusual strength and constancy of volume at high temperatures are being widely used in the iron and steel industry in a number of places. Vacuum pressed brick are being used for blast furnace linings, checkers of blast furnace stoves, upper checkers of open-hearth regenerators, firing zones of shaft lime kilns, and other services requiring especially high-density brick. The use of insulating brick has proved most advantageous in intermittently operated furnaces and in annealing furnaces having "stepped" operating cycles with rapid changes from one temperature to another. E.J.V.

Refractoriness-under-load of chrome-magnesite brick. A. E. DODD. *Brit. Clayworker*, **46** [548] 329–30 (1937).—Chrome-magnesite brick show considerable subsidence at temperatures 200°C or more below their temperature of failure in the standard refractoriness-under-load test. No direct relation has been found between the results of the standard under-load test and the contraction exhibited after 5 hr. heating at 1500°C under the same load (50 lb./sq. in.), and a maintained temperature test of the type described is necessary to classify chrome-magnesite brick according to their ability to withstand the high-temperature stresses imposed in the sprung roofs of basic open-hearth steel furnaces. R.A.H.

Refractory concretes for coke ovens and furnaces. W. M. MCGRUE. *Blast Furnace & Steel Plant*, **25** [6] 624–27 (1937).—High-alumina cements, when used as binders of refractory aggregates, make refractory concrete which is

highly resistant to temperatures encountered in many industrial furnaces, including coke ovens. The high-alumina content and absence of free lime in these binders account for their value in refractory installations. In refractory concrete 15 to 18% of minus 100-mesh grog is important to provide workability and to aid in development of fired strength under operating temperatures. The mixes are based on 1:3½ to 1:4 ratios of high-alumina cement to crushed fire brick, graded so at least 50% passes 8-mesh. The larger sizes of aggregate are governed by the thickness of application. Aggregates used for heat-resisting concrete have included crushed fire brick, slag, Haydite, etc. In some cases insulating aggregates such as C-3 Sil-O-Cel and vermiculite have been satisfactorily used to increase the insulating properties of the top paving of coke ovens. E.J.V.

Refractory trends and developments during 1936. JOHN D. SULLIVAN. *Blast Furnace & Steel Plant*, **25** [1] 88–91 (1937).—No revolutionary developments were made during 1936 in refractories, though in manufacturing, techniques and products were improved. The outstanding development of interest to American metallurgists and ceramists was the successful installation of chrome-magnesite roofs in European open-hearth furnaces for steel melting, whereby increased furnace temperatures are attainable. **1937.** *Ibid.*, **26** [1] 64–67 (1938).—During 1937 special super-duty flint fireclay brick, made by refiring regular super-duty brick to about cone 18, were produced. They were widely used in checker chambers, the glass industry, and malleable air furnaces. Tabular corundum, developed by the Aluminum Co. of America, is made into brick by use of ball clay and diaspore as bonding agents; it shows high refractoriness and excellent load-bearing properties at elevated temperatures. S. describes eradicating surface blemishes from silica brick by use of ammonia in the tempering water or of barium nitrate on the surface to obscure the color effect. Natural silica firestone and other sandstones are being used in increasing amounts. A chrome-magnesite brick (Spinella), made in England, shows long life when used in open-hearth roofs adjacent to the skewbacks on the back wall. They are also used in construction of ports, back walls, and front walls of basic open-hearth furnaces. Merwinite, made from 400 parts by weight dolomite and 83 parts by weight silica sand, clinkered at 2800°F, crushed to 6- to 8-mesh, tempered with 6 to 8% water, pressed into brick, and fired to cone 14 to 16, is claimed to withstand higher temperatures than fireclay refractories, is resistant to open-hearth slags, has a lower thermal conductivity than magnesite refractories, and has slight hydraulic properties. A new bottom material (Thomasite) is a calcium ferrite-bonded high magnesia refractory comprising about 79 periclase, 13 $CaO \cdot Fe_2O_3$, and 8% $CaSiO_3$. At furnace temperatures, the $CaO \cdot Fe_2O_3$ fluxes part of the $CaSiO_3$ to form about 16% bond. Monofrax cast refractories fall into three groups: (1) Monofrax L, consisting of 90% or more Al_2O_3 mostly in the α form; (2) Monofrax H which refers to mixes of high purity made from chemically pure materials, one being largely β Al_2O_3, made by incorporation of 2 to 10% Na_2O; and (3) Monofrax K, consisting of a group of mixes containing 80% or more Al_2O_3. See *Jour. Amer. Ceram. Soc.*, **19** [8] 213–33 (1936). E.J.V.

Savings with insulating refractories. J. G. COUTANT. *Heat Treating & Forging*, **23** [12] 630 (1937).—The application of "massless" type insulating refractories greatly reduces the heat capacity of furnaces and improves the insulating properties. The heat lag of the furnace is lessened, the output is increased, and fuel economy is improved. Heat balances of two furnaces are shown, showing an increase in heat absorbed by the work of 230% for the one built of insulating refractory with the same heat input to the furnace. See *Ceram. Abs.*, **16** [9] 277 (1937). S.S.

South African materials for silica refractories. V. L. BOSAZZA. *Trans. Geol. Soc. S. Africa*, **39**, 465–78 (1937).—B. gives analyses of raw materials for silica refractories from S. Africa and other countries. A.H.E.

Temperature conditions in boiler furnaces. RALPH A. SHERMAN. *Bull. Amer. Ceram. Soc.*, **17** [2] 43–55 (1938).

Testing and properties of heat-insulating materials. A. H. JAY AND L. LEE. *Brit. Clayworker*, **46** [548] 318–23 (1937).—The thermal conductivity of commercial insulating brick having a maximum safe temperature of not more than 1000°C is of the order of 1.0 B.t.u. and that of brick having a maximum safe temperature of over 1000°C is of the order of 2.0 B.t.u. Provided an insulating brick has reasonable thermal resistance, the most important consideration is maximum safe temperature. The crushing strength of insulating materials is low compared with that of less porous refractories. The choice of an insulating material for a given purpose can be made by use of data given in this paper, particularly the value of thermal conductivity, maximum safe temperature, and crushing strength, together with a comparison of costs in relation to heat saving. R.A.H.

Texture. A. E. DODD. *Refrac. Jour.*, **13** [5] 293 (1937).—D. discusses the relationships between texture and the various characteristics of refractories. A definite relationship between texture and spalling resistance has not as yet been established; however, there appears to be a functional relationship between texture and slag penetration with its ultimate slag attack. Heat transmission of a refractory also seems to be a function of the texture. M.C.S.

Types of refractories for open hearths. FEDERICO GIOLITTI. *Metal Progress*, **32** [4] 384, 402 (1937).—Difference in raw material supplies has led to the use of different types of refractories in Europe and America and to somewhat divergent research trends. Silica or Dinas brick are the most commonly used refractories in European open hearths, largely for economical reasons; "black Dinas" brick, made of crystalline quartzites of varying qualities, are increasing in popularity. Magnesite brick are used in Europe only for bottoms and for sub-slag-level wall sections, the unfired magnesite being preferred. Exceptionally good results with chrome-magnesite brick have been obtained in open hearths heated by coke oven gas and running at very high temperatures. F.P.P.

Washington tests new uses of olivine. ANON. *Mining Jour.* [Phoenix], **21** [7] 64 (1937).—Preliminary experiments by the University of Washington show that an olivine block has a maximum of only 3 or 4% shrinkage when heated and a similar loss in weight. This proves an advantage over magnesite for magnesia brick, which loses about 50% in weight upon heating. A small amount of

magnesia is necessary as a bonding material in making olivine brick. P.G.H.

X-ray survey of refractories. A. H. JAY AND J. H. CHESTERS. *Brit. Clayworker*, **46** [548] 323–28 (1937).—Debye-Scherrer patterns are given for the following constituents of refractory materials: quartz, cristobalite, tridymite, magnesia, alumina, magnesium aluminate, chromite, mullite, and forsterite. Information regarding the size of crystals and the degree of preferred orientation has been obtained by the monochromatic pinhole method. Quartzites are found to vary greatly in crystal size, both within a given sample and from one sample to another. On firing for 1 hr. at 1450°C they yield varying amounts of cristobalite, the amount of conversion increasing with the fineness of the crystals and the amount of impurity present. Used silica brick from open-hearth furnace roofs show marked crystal development, the cristobalite in the first zone and the tridymite in the second zone being about 0.01 cm. in diameter, compared with less than 0.001 cm. in the unused brick. Coarse crystallinity is not an essential feature of magnesite brick of high thermal shock resistance. Chrome ores give patterns that are very characteristic of their source. With certain ores the pattern is so consistent and unlike that of any other ore examined that it can be used to identify the chrome ore employed in the manufacture of certain chrome-magnesite brick. An examination of the chrome-magnesite brick after exposure to iron oxide confirms the previous suggestion that the bursting observed is due to solid solution of magnesite in the isomorphous chromite. All the aluminum silicate refractories examined show considerable amounts of mullite. The siliceous fireclay brick show, in addition, a considerable amount of residual quartz and some cristobalite. The mullite crystals increase with heat treatment. R.A.H.

BULLETIN AND BOOK

Development of pyrophyllite refractories and refractory cements. A. F. GREAVES-WALKER, C. W. OWENS, JR., T. L. HURST, AND R. L. STONE. *Univ. of N. C. Eng. Expt. Sta. Bull.*, No. 12, 105 pp.; abstracted in *Ceram. Age*, **30** [4] 121 (1937).—The results of an extensive investigation of the practicability of manufacturing high-grade refractory products from pyrophyllite are presented. F.G.H.

Magnesite as a Refractory. A. W. COMBER. Charles Griffin & Co., Ltd., London. 120 pp. Price 4s. No. 8 of Griffin's "Industrial Textbooks" edited by Percy Longmuir. C. gives information on the following subjects in a concise, direct, and condensed form which is convenient to students and works foremen: (1) early experiments with magnesite, (2) compact and crystalline magnesite, (3) sources of supply, (4) calcination methods, (5) manufacture of magnesite brick, (6) chemical and physical properties, (7) electrically fused magnesite, (8) magnesite in the steel industry, (9) other uses, and (10) British Empire resources. Chemical compositions and references and an index are included. A.P.SOM

PATENTS

Checkerwork. E. A. MCKELVY. U. S. 2,107,675, Feb. 8, 1938 (July 31, 1937).

Extracting alumina from bauxite. T. R. HAGLUND. Brit. 478,489, Feb. 2, 1938 (Oct. 23, 1936).

Furnace walls. BABCOCK & WILCOX, LTD., AND LUMMUS CO. Brit. 478,425, Feb. 2, 1938 (May 21, 1935).

Manufacture of brick, blocks, and other shaped articles from materials typifiable by dolomite. F. L. DUFFIELD. Brit. 478,707, Feb. 2, 1938 (July 21, 1936).

Manufacture of heat- and sound-insulating material. B. NEUHOF. Brit. 477,763, Jan. 19, 1938 (April 3, 1936).

Terra Cotta

Causes of poor adherence of engobes to ceramic bodies. ANON. *Schweizer. Tonwaren-Ind.*, **40** [8] 5–7 (1937); abstracted in *Chem. Zentr.*, **1937**, ii, 3362.—The sudden and periodical appearance of cracking and flaking of engobe on roof tile can be ascribed to a series of factors, such as the unsatisfactory working of the engobe (too short grinding, filling the mill with too much material at a time, too thickly liquid slip, dust on brick, too rapid drying of the brick with the engobe, irregular firing, etc.). M.V.C.

Ceramic tile in refrigerated enclosures. E. LAUSER. *Z. ges. Kälte-Ind.*, **44**, 6–8 (1937); *Brit. Chem. Abs.–B*, **56**, 1142 (1937).—L. describes methods of fixing the tile to a cork undersurface.

Stoneware towers. C. H. BUTCHER. *Chem. Industries*, **41** [4] 347–50 (1937).—Factors affecting the size and construction of stoneware towers and the selection of the proper tower packings are discussed. P.G.H.

PATENT

Roofing tile. W. LUDOWICI. Brit. 477,937, Jan. 19, 1938 (Jan. 11, 1937).

Whiteware

Alkaline casting slip: I. H. W. WEBB. *Trans. Ceram. Soc.*, **33**, 129–40 (1933–34).—Technical aspects of the alkaline casting slips are dealt with, and an endeavor has been made to develop the simplest theoretical explanations which appear to fit the facts. The numerous theories of the mechanism of deflocculation are not discussed in detail since the investigations, although they have a bearing on the problem, were not designed for this purpose. Deflocculation of certain types of pottery bodies appears to be influenced in a marked degree by the presence of protective colloids, which may either be present in the clay or added with the deflocculant. The presence or absence of such colloids may determine the type of sodium silicate to be used or, alternatively, the proportion of soda ash to sodium silicate. Sodium metasilicate and sodium tannate were investigated as deflocculants. The latter is very effective for bone china. Specific differences in casting rate, tensile strength, and hardness of cast were established for soda ash as a deflocculant compared with sodium silicate. The effect of alkaline scrap in the clay used for casting slip was investigated. The variation in casting rate and tensile strength of the cast with the fluidity of the slip was

shown. W. discusses deflocculants and their actions in the following papers: **Effect of the SiO_2/Na_2O ratio in silicates on the fluidity of the slip.** H. W. Webb and E. H. Sandland. *Ibid.*, pp. 140–44. **Protective colloids in bone-china slips.** H. W. Webb and R. Lockett. *Ibid.*, pp. 144–49. **Use of casting scrap in alkaline slip.** H. W. Webb and J. E. Brough. *Ibid.*, pp. 149–52. **Casting rate of the slip and the tensile strength of the cast.** H. W. Webb, S. B. Johnson, and J. E. Brough. *Ibid.*, pp. 152–63. **Discussion.** T. Simpson *et al.* *Ibid.*, pp. 165–67. R.A.H.

Auxiliary fluxes in combination with different feldspars in an earthenware body. Ralston Russell, Jr., and Arthur S. Watts. *Ceram. Age*, **26** [6] 219–21 (1935).—Six auxiliary fluxes were employed in combination with three different feldspars in a body of the earthenware type which carried a higher than normal feldspar content in order to reduce the amount of auxiliary flux required. Oxford, Buckingham, and Connecticut feldspar were used. The earthenware body had the following composition: feldspar 12, No. 4 Kentucky ball clay 25, Florida kaolin 8, Georgia china clay 20, and flint 35%. The auxiliary fluxes were added to this body in 1, 2, and 4% amounts. The bodies, prepared in the form of cylindrical bars, were fired at cones 7, 9, and 11. Detailed observation of the fired bars and modulus of rupture and absorption determinations indicate that (1) the feldspar used has a definite influence on the type of auxiliary flux which is most effective; (2) at cone 7, a marked improvement with respect to both absorption and modulus of rupture is effected by the addition of 1% of auxiliary flux, this improvement being more noticeable with 2 and 4% additions; (3) at cone 9, the feldspars naturally produce added vitrification over cone 7, but the improvement produced by 1% of auxiliary flux also is evidenced; 2% additions of auxiliary fluxes noticeably improve all bodies except those in which Connecticut feldspar is used, where only a few fluxes produced beneficial results; the addition of 4% auxiliary flux appears to be justified in the bodies containing Buckingham and Oxford feldspars but is of doubtful benefit with the Connecticut feldspar; and (4) at cone 11, the feldspars are doing their maximum work, and there is some doubt as to whether the use of auxiliary fluxes is justified in many cases where the firing temperature is above cone 9; auxiliary flux in 2 or 4% amounts may be justified where zero absorption and a high flint content are sought. The results appear to justify the use of auxiliary flux glasses, especially where the feldspar content is low and a minimum practical solubility is required. See *Bull. Amer. Ceram. Soc.*, **13** [6] 162–63 (1934). F.G.H.

Beginnings of white tableware. Harold Edison Stewart. *Bull. Amer. Ceram. Soc.*, **17** [2] 84–86 (1938).

Computation of heat treatments for whiteware bodies. W. W. Meyer. *Jour. Amer. Ceram. Soc.*, **21** [3] 75–79 (1938).

Engineering methods show their worth in efficient pottery manufacture. Theo. R. Olive. *Chem. & Met. Eng.*, **44** [8] 412 (1937).—The Court St. plant of the Onondaga Pottery Co. has been designed and constructed to permit the most efficient methods of manufacture. Special precautions have been taken to reduce the dust hazard both in the handling of the raw materials and in the mixing of the various batches. The batches are prepared through a definite and closely controlled system. The raw materials are mixed and blunged in stainless steel agitators, the slip is carefully screened, and the magnetic impurities are removed in a magnetic separator. The slip is de-aired and, in the case of jiggered bodies, filter pressed; for the casting process the slip is prepared with the necessary electrolytes. The formed ware is carefully dried in fully controlled driers and fired in continuous kilns which are highly versatile from the standpoint of possible fuel to be used and the rate at which the cars may proceed through the kiln. M.C.S.

Lightning strokes in field and laboratory: II. P. L. Bellaschi. *Elec. Eng.*, **56** [10] 1253–60 (1937).—B. investigates the lightning stroke phenomena in the laboratory on paper, porcelain, micarta, Fuller board, and copper plates. The lightning stroke effects on the materials tested indicate a circular area for the core of the lightning proportional to the current in the discharge. The apparent area is 0.24 sq. in. for 75,000 amp. The discharge on a porcelain surface results in burning of the thin glaze while the center of the path is flaked, indicating that the highest temperature has been maintained there. P.G.H.

Manufacture of sanitary ware by unicast method and gas-fired kilns. J. B. Nealey. *Ceram. Age*, **27** [5] 113–15 (1936).—N. describes the manufacture of sanitary ware by the unicast method, whereby the tank is combined with the wash bowl in a single and compact unit. Illustrated. F.G.H.

Manufacture of semiporcelain. Colley A. Shorter and H. L. Steele. *Pottery Gaz.*, **63** [727] 69–75 (1938).—There is no material difference in composition of the better types of earthenware and semiporcelain; the differences are the result of the different materials employed and the differences in methods of handling throughout the manufacturing processes. The reason for opacity of semiporcelain and earthenware in contrast to porcelain and china is due to the low proportion of fluxing material and to carrying the mass not to a state of fusion but only to the cementing stage. Raw materials, mechanized production, manufacturing processes, firing methods, glost oven, decoration, hand painting and lithographing, and pottery colors are discussed. E.J.V.

Moduli of elasticity and rupture of electrical porcelain. Takeo Kanno. *Jour. Japan. Ceram. Assn.*, **45** [532] 209–12 (1937).—Experiments were made on the effects of the duration of grinding the body batch and body material and of chemical composition of the body on the modulus of elasticity (E) and the modulus of rupture (f). Results are as follows: (1) for the same batch composition f increases with increase in time of grinding the batch, whereas M increases only slightly; (2) the values of E, f, and E/f are markedly influenced by the chemical composition of bodies; (3) substituting feldspar for other fluxes gives stronger porcelains (except when lead oxide is used alone) and lowers E/f. A batch with barium frit gives the strongest porcelain. E, f, and E/f of the nine commercial electrical porcelains were 398,000 to 672,000, 490 to 970, and 520 to 950, respectively.

CHEMICAL COMPOSITION AND STRENGTHS

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	B_2O_3	ZnO	BaO	SrO	PbO	E (kg./cm.²)	f (kg./cm.²)	E/f
70.1	25.7		0.3	0.3	3.75							717,000	940	730
26.6	54.2	1.0	2.7	0.7	0.7	0.3	0.5		3.0		10.4	963,000	2020	480
27.8	52.5	0.8	2.7		1.1	0.5	3.1	0.7			10.9	907,000	1800	500
29.6	50.5	0.7	2.2	0.7	1.3	0.5	0.6			2.8	11.1	930,000	1750	530

S.K.

Pipes of hard porcelain. G. EHLERS. *Rundschau Tech. Arbeit*, **16**, 161 (June 17, 1936); abstracted in *Ceram. Age*, **28** [4] 123 (1936); see *Ceram. Abs.*, **16** [8] 251 (1937). F.G.H.

Plumbiferous overglaze colors: I. KEN-ICHI UGAI. *Jour. Japan. Ceram. Assn.*, **45** [532] Supp. 1–34 (1937).—Experiments were made on the effect of the chemical composition of fluxes and coloring materials on the color, adherence, resistance to acid, etc., of overglaze colors. Fluxes were made by a frit kiln and ground wet by a mechanical mortar. The colors were hand-painted on a talc-lime glaze on which colors usually adhere poorly and fired to 650°, 670°, and 700°C in an electric kiln. Acetic acid (4%) was used for the test of the resistance to acid. The fluxes were prepared in four groups from 30 to 95% of red lead, 35 to 0% of quartz, and 70 to 0% of borax, boric acid, and potassium carbonate. **II.** *Ibid.*, [533] Supp. 35–40; 534] Supp. 41–48.—The pulverizability, firing range, fluidity, color, adherence, resistance to weathering, and other defects of the fluxes are given and illustrated with tables and diagrams. The resistance of the fluxes to discoloring action of cold 4% acetic acid in 15 or 30 min. is also illustrated for each group. The general conclusions on the discoloration are that it is most strongly affected by the content of lead, *i.e.*, the more the Pb content, the more the discoloration is and the less the quartz content, the greater is the discoloration; if the contents of red lead and quartz remain constant, boric-acid batches are more resistant than those batches which contain both boric acid and alkali. S. K.

Porcelain and earthenware at the Leipzig spring fair, 1936. HARRISON LEWIS. *Ceram. Age*, **27** [6] 160–61 (1936).—Trends and developments in the manufacture of European porcelain and earthenware are described. F.G.H.

BOOK

Electrical Insulation Materials: Development, Manufacture, Uses (Elektrotechnische Isolierstoffe: Entwickelung, Gestaltung, Verwendung). R. VIEWEG, editor. Julius Springer, Berlin, 1937. 295 pp. 235 illustrations. Lectures on organic and inorganic insulation materials have been compiled. The section on ceramic materials, prepared by W. Weicker, deals with porcelain, steatite, and new titanium compounds. W. Fischer describes electrical insulation materials for heating technique. Such materials consist of highly refractory oxides, such as MgO, Al_2O_3, ZrO_2, BeO, ThO_2, Sinterkorund, and fused quartz. The requirements and physical properties of these compounds are described. New designs are shown. L. E. THIESS

PATENTS

Ceramic composition and method of making. A. H. FESSLER (General Motors Corp.). U. S. 2,106,598, Jan. 25, 1938 (June 6, 1934). The method of making a non-plastic ceramic composition consisting chiefly of mullite and cordierite consists in preparing a mixture of alumina and silica in substantially the mullite ratio, together with magnesia, fusing the mixture, and permitting it to cool slowly, so as to produce mullite and cordierite in a glassy matrix.

Method and apparatus for forming ceramic bodies. GENERAL MOTORS CORP. Brit. 477,287, Jan. 7, 1938 (June 27, 1935).

Method and apparatus for molding covered ceramic receptacles. B. S. PURINTON. U. S. 2,106,415, Jan. 25, 1938 (July 27, 1936).

Spark plug. FRED STEMMELER. Can. 371,075, Jan. 4, 1938 (Jan. 21, 1937). G.M.H.

Equipment and Apparatus

All-glass apparatus for measuring the density of glass by flotation. E. SEDDON. *Jour. Sci. Instruments*, **14** [11] 376–78 (1937).—S. describes an all-glass apparatus for use in determining the densities of glasses by the immersion method. The density of a liquid is adjusted so that a small sample of glass immersed in it remains suspended in equilibrium. The densities of glass and liquid are then the same. The liquid is then transferred to a calibrated density bottle or pycnometer, and its density is determined by one weighing. The apparatus is designed to be used in a thermostatically controlled water bath. Density is determined by varying the proportions of a binary liquid mixture. Values for the density of glass at 25°C may be repeated to within ±0.0001 g./ml. Liquid pairs for immersion are listed for densities from 1.80 (fused B_2O_3) to 3.0 (high lead glass). Illustrated. J.L.G.

Barrel finishing of metal products: I. H. LEROY BEAVER. *Products Finishing*, **1** [5] 18–22 (1937). **II, Factors in the selection of burnishing barrels.** *Ibid.*, [6] 35–40. **III, Factors in the selection of metallic burnishing materials.** *Ibid.*, [7] 28–36. **IV, Use of soap in the barrel burnishing process.** *Ibid.*, [8] 26–34. **V, Barrel burnishing defined.** *Ibid.*, [9] 20–28. **VI, Questionnaire.** *Ibid.*, [10] 24–32. **VII, Composite burnishing analysis.** *Ibid.*, [11] 22–30. **VIII, Factors in the selection of fibrous materials for drying out, polishing, cutting down, and mat finishing.** *Ibid.*, [12] 30–36; for Part **IX** see *Ceram. Abs.*, **17** [1] 27 (1938).

Belt conveyers. ANON. *Lubrication*, **22** [2] 13–24 (1936).—Belt conveyers not only are labor-saving devices speeding up production but reduce personal hazards to plant personnel. The basic principles of design are discussed. Rubber belts are recommended for wet or dry material which is relatively nonplastic. A stitched canvas belt is used for higher temperatures, and a cotton belting is suitable for handling light, dry, nonabrasive materials at normal temperatures. Power consumption is important and may be reduced by the use of free rolling idlers. The advantages of antifriction bearing and positive lubrication with a low torque grease capable of functioning over a wide range of temperatures and the sleeve type bronzed-bushed bearing are stressed. Important factors in belt conveyer troughing and return rolls are (1) adjustment and alignment of each to conform as nearly as possible to the operating line of the belt and (2) prevention of contamination of the lubricants. H.E.S.

Carbon-free alloys, hard as tool steel. WESLEY P. SYKES. *Metal Progress*, **32** [5] 649–54 (1937).—Iron-cobalt-tungsten alloys, although nominally free of carbon, reveal striking similarities in their physicochemical properties to the high carbon steels so widely used as tool materials. S. exhaustively investigates this analogy from the standpoints of freezing range, structure, nature of disperse phase, transformation range, and room-temperature solubility of excess constituent. Hardness changes after given time periods during isothermal transformation at various temperatures are plotted. F.P.P.

Celite type high-temperature thermal conductivity apparatus. C. E. WEINLAND. *Proc. Amer. Soc. Testing Materials*, **37** [Part II], 269–76 (1937).—W. brings up to date the description of this type of apparatus, four units of which are now in daily use for testing thermal insulation at temperatures up to 1600°F. The present method of constructing heater plates is described together with the assembly of the apparatus with metallic isothermal plates and heaters for the cold faces of the test samples, all of which are modifications introduced since the previous description was published (*Ceram. Abs.*, **8** [5] 341 (1929)). A simplified arrangement of the thermocouples is now used. W. describes a wattmeter circuit for electrical power measurement which provides wattage readings over an extended range on a large number of power circuits, with the elimination of certain troublesome circuit errors and with the minimum of instrumental equipment. The method of conducting the test makes possible results in a form approximating the mathematical concept of conductivity with attendant advantages in the use of the results in heat-loss calculations. Typical test results and calculations are shown. R.A.H.

Classification of methods of mechanical analysis of particulate materials. PAUL S. ROLLER. *Proc. Amer. Soc. Testing Materials*, **37** [Part II], 675–83 (1937).—The methods are divided into classes depending on the underlying principles involved. R. discusses each class from the standpoint of adequacy of principle and of technique. The classes are (1) direct observation by means of the microscope, (2) fractionation and recovery of fractions, (3) sedimentation with direct physical measurement of the rate of settling, (4) sedimentation with indirect measurement of the rate of settling, and (5) measurement of surface area of the material without determining the size distribution. R.A.H.

Columbium in steels—plain chromium and chromium-nickel. W. D. WILKINSON, JR. *Metal Progress*, **32** [5] 661–65 (1937).—W. discusses the history and technology of producing columbium and cites its advantages as an addition to stainless steel. Because of its great affinity for carbon, columbium combines with the latter in stainless steel and thus prevents the formation of chromium carbide, the precipitation of which is believed to be responsible for intergranular corrosion of these steels. F.P.P.

Comparative tests with grease-lubricated artificial resin and metal bearings for intermittent crane service. H. ERNST. *Mitt. Forsch.-Anstalt. Gutehoffnungshütte Oberhausen A.-G.*, **5** [9] 243–51 (1937).—Bearings with bushings of red brass, cast Fe, and artificial resins were tested under exactly similar conditions in a test arrangement imitating the intermittent crane service. The friction coefficients of various synthetic materials are given in curves for different speeds. In general, the six investigated materials are superior to red-brass bearings in regard to friction, are less sensitive to inaccuracies of mounting, and do not require as long a period of running-in before using; this is particularly true in the range of low speeds and high pressures. As the temperature of such bearings is higher because of low heat conductivity, a grease should be used for lubrication having a high dripping point. Bushings for high pressures should be made of irregularly pressed material but not of material arranged in layers transverse to the axis of the bearing. Cast-Fe bushings can replace red brass only in cases of low loads. M.H.

Controlling a "controlled atmosphere." A. E. KROGH. *Metals & Alloys*, **8** [2] 47–51; [3] 83–88 (1937).—K. gives a detailed description of the Analygraph, which records changes in thermal conductivity of the gas atmosphere through the effect of such changes on the balance of a Wheatstone bridge, one arm of which is a filament of high temperature coefficient of resistance, electrically heated and inserted in an unheated sample of the atmosphere. Data on the effects of atmosphere composition on hot steel and data on the sensitivity of thermal conductivity as an indication of gas activity are given. F.P.P.

Correlated abstract on corrosion and corrosion-resistant metals and alloys. V. V. KENDALL. *Metals & Alloys*, **8** [11] 313–19; [12] 355–60 (1937); **9** [1] 21–22, 26 (1938).—K. reviews symposia on corrosion-resisting metals presented in 1936 before several societies. Fifty-four papers and discussions are digested, and the data are correlated in tables and compared. F.P.P.

Crucible tool steel—its manufacture. H. C. BIGGS. *Metal Progress*, **32** [6] 773–75 (1937).—B. describes crucible process for tool-steel manufacture, which for almost 200 years maintained a record of high quality, challenged only recently by electric-arc and induction-furnace products. F.P.P.

Dew-point potentiometer for determining the moisture content of gases. S. S. STACK. *Gen. Elec. Rev.*, **41** [2] 106–108 (1938).—The dew-point potentiometer is a new portable instrument which has been found convenient in making measurements of the amount of moisture present in the furnace atmosphere. A small quantity of gas to be

measured is brought into contact with the face of a thin metallic mirror to which a thermocouple is attached. An arrangement is provided for cooling this mirror to the dew-point temperature of the gas; the potentiometer is used for measuring this temperature. The moisture content is obtained from a chart for converting dew-point temperature into moisture content. Illustrated. L.E.T.

Dorr multizone classifier. A. ANABLE. *Mining Jour.* [Phoenix], **21** [1] 44–46 (1937).—A new classifier utilizes turbulence, high pulp velocity, and quiescent settling to improve separation. The equipment may be used either for additional grinding-mill capacity or to gain a greater degree of fineness. P.G.H.

Dupor plate respirator. H. S. COVER CO. *Mining Jour.* [Phoenix], **20** [13] 41 (1936).—A respirator having a 24-sq. in. filtering surface is illustrated and described. See "Respirator—," *Ceram. Abs.*, **15** [4] 128 (1936). P.G.H.

Dust counter. WILLSON PRODUCTS, INC. *Mining Jour.* [Phoenix], **20** [17] 42 (1937).—A dark-field microscope dust counter and sampling device is described. P.G.H.

Exhibit at American Mining Congress. HARDINGE CO., INC. *Mining Jour.* [Phoenix], **21** [9] 57 (1937).—A new sound-control system for regulating the flow of feed into the ball mill is presented. A microphone is placed near the ball mill which registers the sound on an electric ear. When the sound is reduced, the unit feeds material into the mill. The increase in the noise in the mill, which occurs as more material is fed into it, causes the unit to cut off the feed after the sound reaches a certain predetermined point. This device gives from 5 to 20% additional capacity. P.G.H.

Froth flotation and agglomerate tabling of nonmetallic minerals. OLIVER C. RALSTON. *Trans. Can. Inst. Mining & Met.* (in *Can. Mining & Met. Bull.*, No. 307), **40**, 691–726 (1937).—R. describes flotation of the following: phosphates, limestone, magnesite, dolomite, graphite, coal, carbonaceous material, bituminous sands, halite, sylvite, fluorite, zircon, talc, barite, kyanite, chromite, cassiterite, feldspar, beryl, spodumene, nephelite, quartz, mica, sericite, clay, bauxite, W minerals, ilmenite and rutile, Mn ore, oxidized Fe ore, and S. Agglomeration with tabling of the following is described: phosphate, limestone, soluble salines, kyanite, fluorite, and coal. 126 references. See "Nonmetallics—," *Ceram. Abs.*, **16** [6] 182 (1937). A.H.E.

High-precision refractometer. A. ARNULF AND N. WINTER-KLEIN. *Rev. Optique*, **16** [8] 267–72 (1937).—Apparatus in customary use for rapid determination of refractive index requires the application of the sample being measured against a reference prism. The apparatus described by the authors still requires application to a reference prism but avoids any influence of the angle between the surfaces on the results obtained. F.P.P.

Home-made electric furnace. E. BERTOLET AND J. I. OSER. *Jour. Chem. Education*, **14** [10] 492–94 (1937).—The construction of a small arc furnace costing about $8.00 for materials is described in detail. P.G.H.

Improved illumination for microscopes. PETER P. TARASOV. *Metal Progress*, **32** [3] 266–67 (1937).—An incandescent lamp (similar to the sun lamp used for therapeutic purposes) may be used, in place of the conventional carbon arc, for micrographic work. Tungsten electrodes provide a permanent, nonfluctuating light with about the same photographic efficiency as the arc. The lamp operates at 11 volts and about 30 amp. F.P.P.

Improvement in the adaptability of the Tuckerman strain gage. L. A. MEISSE. *Proc. Amer. Soc. Testing Materials*, **37** [Part II], 650–54 (1937).—Transfer mechanisms have been developed for improving the adaptability of the Tuckerman optical strain gage. They consist of a special construction of parallel flexure plates which transmit the movement from the specimens to the gage body. Some commercial applications of the system are given, and a broader use of similar flexure-plate transfers with other types of strain gages is shown. The broadening of the adaptability of strain gages to general displacement measurements widens their scope of usefulness in the testing laboratory. R.A.H.

Instrumentation; exact science combined with fine art. M. F. BEHAR AND RICHARD RIMBACH. *Metal Progress*, **32** [4] 487–97, 500 (1937).—A comprehensive review of present instrumentation and its future possibilities is presented. The topics covered include optical pyrometers; temperature-control instruments; blast-furnace, open-hearth, and heat-treatment furnace instrumentation; plant and laboratory testing equipment; permanent calibration; advances in optical equipment; and automatic inspection departments. F.P.P.

Investigation of power reduction and moisture control in waste-heat drying. J. M. MCKINLEY AND R. R. ROBINSON. *Jour. Amer. Ceram. Soc.*, **21** [3] 104–108 (1938).

Isograph—a mechanical root-finder. R. L. DIETZOLD. *Bell Lab. Record*, **16** [4] 130–34 (1937).—In many practical and scientific studies and investigations it becomes necessary to solve a polynomial of high degree. Polynomials of eighth degree are not infrequent and the determination of the roots becomes increasingly difficult and time-consuming, the higher the degree. An isograph, or mechanical root-finder, has been constructed by means of which the roots of the polynomial whose highest power is not greater than ten may be quickly and easily determined, irrespective of whether the roots are real, complex, or multiple. P.S.D.

Large-size roll crusher. PIONEER GRAVEL EQUIPMENT MFG. CO. *Roads & Streets*, **80** [9] 72 (1937).—A crusher with rolls 54 in. in diameter for use in commercial quarries and large plants is described and illustrated. P.G.H.

Making vacuum apparatus from ceramic material. H. HANDREK. *Angew. Chem.*, **49**, 853 (1936); abstracted in *Ceram. Age*, **29** [1] 17 (1937); see "Ceramic—," *Ceram. Abs.*, **16** [3] 94 (1937); "Methods—," *ibid.*, **14** [3] 75 (1935). F.G.H.

Material handling equipment. W. BARNES. *Crushing-Grinding-Mining & Quarrying Jour.*, **3**, 52–60 (1935).—The single bucket excavator is described. E.W.S.

Material handling equipment. J. R. THOENEN. *U. S. Bur. Mines Information Circ.*, No. 6814; reprinted in *Crushing-Grinding-Mining & Quarrying Jour.*, **3**, 10–22, 110–13, 160–61 (1935).—T. discusses sand and gravel excavation power scrapers and slackline cableway excavators, together with power-scraper working ranges, power plants for power scrapers, and capacities of scrapers.

A good summary and extensive tables are given. E.W.S.

Means of increasing the light transmitted by a disappearing filament pyrometer of precision. VAUGHAN H. STOTT. *Jour. Sci. Instruments*, **14** [11] 370–72 (1937).—After a short explanation of the main principles of a disappearing filament pyrometer, S. points out that a fivefold increase in brightness of the field may be obtained by substituting a slit, set parallel to the filament, for the small circular aperture placed between the erecting lens and the ocular. This alteration facilitates the calibration of the instrument at the gold point and extends the useful range of measurement 80°C at the lower end of the scale. J.L.G.

Measuring high temperatures in apparatus and industrial laboratories. YVES LETORT. *Céramique*, **40** [595] 167–81 (1937).—L. reviews elementary data on thermometry, dealing with (1) Hg thermometers, (2) gas thermometers, (3) causes of multiple errors, (4) resistance thermometers, (5) thermoelectric couples, (6) pyrometers with total radiation, and (7) monochromatic pyrometers. Principles of Chevenard's calorimetric method, ceramic pyrometric cones, and the "gaseous discharge" method are discussed. M.V.C.

Mechanical preparation of nonmetallic minerals. PAUL M. TYLER. *Trans. Amer. Inst. Mining Met. Engrs.*, **112**, 785–823 (1934).—T. reviews methods used in preparing abrasives, bauxite, barite, cement, chalk, clay, cryolite, diatomite, feldspar, gypsum, kyanite, magnesite, mica, mineral pigments, pyrophyllite, sand and gravel, talc, etc. W.D.F.

Mechanical properties of powders: I, Influence of capillary pressure on drying of clay. V. S. VESELOVSKI AND I. A. SELIAEV. *Kolloid. Zhur.*, **2**, 417–23 (1936).—The capillary pressure of liquid contained in the pores of a paste tends to diminish its volume. Hence shrinkage during drying of aqueous clay paste is greater at 20° than at 70° and also greater in vapors of NH_3PH or EtOH. The influence of capillary active substances is more marked when NaOH is added to the paste but less so when the clay is peptized by Na_2SiO_3. **II, Relationship of the mechanical properties of clay to its state of aggregation.** V. S. VESELOVSKI AND V. N. PERTSOV. *Ibid.*, pp. 467–74.—Variation of the rate and volume of sedimentation of clay suspensions and of the strength (θ) and deformability (Δ) of clay pastes with the amount of NaOH or Na_2SiO_3 added is measured. The rate of sedimentation and θ show a minimum and the volume of sedimentation and Δ show a maximum in 0.1 to 0.2% NaOH solution. **III, Effect of moisture on the mechanical properties of clay paste.** V. N. PERTSOV. *Ibid.*, pp. 475–77; *Brit. Chem. Abs.-B*, **56**, 911–12 (1937).—The effort, f, necessary for cutting through a clay-paste cylinder and the maximum compression, δ, of a clay paste sphere which does not cause cracks are measured. δ increases linearly and f decreases hyperbolically with increasing H_2O content. The relationship of δ and f to the thickness of the liquid layer between the clay particles is discussed.

Mechanism of the isograph. R. O. MERCNER. *Bell Lab. Record*, **16** [4] 135–40 (1937); see "Isograph—," this issue, p. 150. P.S.D.

Micrometer ratchet. W. W. WERRING. *Bell Lab. Record*, **16** [5] 162–63 (1938).—Inaccuracies in measuring with a micrometer caliper are often caused by differences in the pressure with which the object being measured is clamped within the instrument. Slight compression of the material being measured or slight distortions of the instrument itself would cause readings to vary. W. describes a new type of micrometer ratchet which makes the measurements under constant pressure of the instrument. The new "ratchet" is subject to less change in calibration than the older friction type, and provisions are made for ready adjustment and calibration by merely removing the ratchet cover. P.S.D.

Microstructures of Mo-Max and 18-4-1 compared. R. G. KENNEDY, JR. *Metals & Alloys*, **8** [10] 289–93 (1937).—The structures of high-Mo low-W tool steel and of the familiar W-Cr-V high-speed steel are shown to be strikingly similar after various heat treatments. F.P.P.

Nonspreading lubricating oils. W. E. CAMPBELL. *Bell Lab. Record*, **15** [5] 149–53 (1937).—In the lubrication of certain types of apparatus, spreading becomes a serious disadvantage, causing bearings to run dry too frequently, driving oil to parts where lubrication is undesirable, and promoting the collection of dust. Cases are cited where nonspreading oils are necessary as a lubricant. C. describes an apparatus by means of which the spreading behavior of lubricants is studied from a series of photographs of oil drops on a polished steel plate, the upper surface of which is accurately flat and carefully leveled. A controlled method of obtaining reproducible drops and controlled humidity conditions are necessary. Investigations of spreading with this apparatus have resulted in the development of lubricating compounds of relatively high nonspreading stability. Fundamental information on spreading has been revealed which may find application in other fields. Mineral oils spread. The rate of spreading of mineral oils is dependent on the viscosity. Fatty oils of animal and vegetable origin, after initial flattening of the drop, do not spread. Equilibrium size of the fatty-oil drop is not related in any way to the viscosity. Fatty oils are considerably less stable to oxidation and tend to gum and form corrosive acids. Adsorbed film thickness on the surface of the solid varies with changing humidity, profoundly affecting adhesion tension and spreading behavior. Photographs and curves show spreading characteristics of a number of mineral and fatty oils. The theory of spreading of liquids on solids is briefly considered. P.S.D.

Opening and closing filter presses. ANON. *Chem. Industries*, **38** [6] 614 (1936).—A hydraulic device for opening and closing filter presses which heightens operating efficiency and reduces costs is illustrated. P.G.H.

Powerful microscope makes tiny objects visible. ANON. *Science News Letter*, **33** [4] 55 (1938).—Effective magnification producing more visible detail as it increases up to 6000 diameters is secured with a new one-ton microscope constructed at Harvard University. The focusing screws are operated by motors to quickly focus the instrument. Objects only 100 times as large as an atom can be seen and photographed. P.G.H.

Pressure cleaning. G. H. DOWNES. *Bell Lab. Record*, **16** [4] 122–26 (1937).—D. discusses the advantages of compressed-air cleaning over other methods of dust

removal from inaccessible parts of equipment to which dust particles are decidedly detrimental. The facilities described consist of a compressor, an exhauster, and their associated accessories. These have proved very valuable in keeping fine telephone equipment in excellent condition. The cleaning technique is discussed. P.S.D.

Psychrometric chart for air-conditioning computations. General Electric Co. *Refrig. Eng.*, **30** [5] 293 (1935). The chart measures 14 x 20½ in. and is printed in light brown and black on a thin layer of noninflammable synthetic resin, obtainable at nominal cost from the General Electric Co. P.G.H.

Psychrometric chart—its construction and use. F. O. Urban. *Refrig. Eng.*, **30** [5] 276–81 (1935).—The chart is constructed from new calculations of the properties of air and water-vapor mixtures based on fundamental data. The arrangement of the lines, which is new in several respects, makes it possible to read all quantities directly from the appropriate scales. The chart is based on 1 lb. of dry air and standard barometric pressure. Sample problems are given. Illustrated. P.G.H.

Psychrometric slide rule for solving air-flow problems. R. W. Kurtz. *Refrig. Eng.*, **33** [2] 130, 132 (1937).—The arrangement of the rule is such that if two of the four fundamental factors, *i.e.*, dry-bulb, wet-bulb, and dew-point temperatures and relative humidity, are known, the other two may be easily determined by one or two settings of the slides. In addition, the following values may be read directly from dry-bulb temperature: lb. of dry air/cu. ft., lb. of dry air and sensible heat in B.t.u./lb. of dry air; from wet bulb temperature: total heat in B.t.u./lb. of dry air in a saturated mixture; from dew-point temperature: vapor pressure and inches of mercury, lb. of dry air/cu. ft. of saturated air, grains of moisture/lb. and/cu. ft. of dry air saturated with moisture. From these values, the results for partially saturated mixtures may be easily determined and evaluated. The rule is 11 x 1⅝ in. finished in white with black figures. P.G.H.

Recent progress in insulation research. J. B. Whitehead. *Elec. Eng.*, **56** [11] 1346–51 (1937).—W. summarizes some of the principal advances in research work on gaseous, liquid, and solid dielectrics during the past year. References are included to both fundamental scientific studies and practical research under service conditions. P.G.H.

Recommendations on de-airing. Ohio Ceramic Industries Assn. *Ceram. Age*, **29** [5] 154 (1937).—Practical observations on the use of de-airing equipment are submitted. See *Ceram. Abs.*, **16** [5] 155 (1937). F.G.H.

Rock-drill lubrication in quarry and mining service. Anon. *Lubrication*, **22** [1] 1–12 (1936).—Cold-weather operation imposes a severe load upon any lubricant which may have to function under exposed conditions. Rock-drill lubrication in mining and quarry operations requires careful consideration because the effective use of air has a direct relation to the power bill. The principles of operation, abrasive effects of dust and dirt, and the methods of lubrication of pneumatic tools are discussed. Normally, there are three distinct types of lubricants used: (1) compounded cylinder oils, required for tools wherein moisture is present, (2) conventional low pour point and light viscosity straight mineral oils, and (3) light- to medium-bodied greases adaptable to heavy, slow-moving tools or parts designed for grease lubrication. H.E.S.

Selection of screen openings for unconsolidated sands. C. J. Coberly. Read before American Petroleum Inst., Chicago, Nov., 1937; abstracted in *Petroleum Eng.*, **9** [2] 96, 98, 100 (1937).—C.'s object was to establish an exact analysis of the bridging problem, to correlate available data with this analysis, and to perform additional experiments to extend the range of variables of existing data. Spherical grains form stable bridges on openings larger than the diameter of the grain, the ratio being two for rectangular openings and three for circular openings. Grain angularity and shape do not materially affect the opening size for a stable bridge but do increase the range of bridging. In mixtures of two grain sizes of either spherical or angular grains, the bridging influence of the larger grain is great in relation to the amount present. P.G.H.

Statistical methods for effecting improvements on a Jones sample splitter. George H. Otto. *Jour. Sed. Petrology*, **7** [3] 110–32 (1937).—O. describes an improved Jones sample splitter which operates faster than the conventional type yet requires no special skill. Samples obtained with it are free from the occasional erratic results obtained with the ordinary Jones splitters. Instructions for operation are given. G.M.H.

Swing-hammer pulverizer. New Holland Machine Co. *Roads & Streets*, **80** [5] 92 (1937).—The hammers of this pulverizer are reversible and interchangeable. The finished material is produced in sizes of 1/16-in. diameter and greater. P.G.H.

Technique in studying body defects. J. O. Everhart. *Ceram. Age*, **30** [2] 38–39 (1937).—Diamond dust carried on the periphery of a sheet-metal disk makes a clean cut through ceramic bodies, whereby a detailed study can be made with respect to lamination defects, character of the bond between grains, degree of porosity, and distribution of grain sizes. F.G.H.

Temperature control in green brick driers. S. N. Makarin. *Stroitel. Materialy*, **1937**, No. 8, pp. 12–17; see "Automatic—," *Ceram. Abs.*, **17** [1] 27 (1938). P.B. & E.S.

Temperature-measuring cones. Robert F. Rea. *Jour. Amer. Ceram. Soc.*, **21** [3] 98–101 (1938); see "Freezing—," *Ceram. Abs.*, **15** [8] 248 (1936).

Thermal apparatus and methods of measurements. Helmuth Moser and Carl Tingwaldt. *Physik*, **6** [1] 1–14 (1938).—The progress made in the development and improvements of thermal apparatus and methods of thermal measurements is reviewed. The following subjects are discussed: thermal expansion measurements, determination of vapor pressure and boiling point, calorimeters, liquid thermometers, resistance thermometers, and thermoelements. Equipment for radiation pyrometry and flame temperatures are also discussed. 116 references. L.E.T.

Thermal microscope shows crystal formation at 3632°F. Anon. *Science News Letter*, **33** [3] 38 (1938).—Search for synthetic abrasives rivaling the diamond in hardness has led to the development of a new "thermal microscope" which makes possible the observation of crystal formation and change even at temperatures as high as 3632°F. P.G.H.

Treatment of filter-press plates by painting, enameling, metallizing, and galvanizing. D. M. WILHELM. *Ceram. Age*, **30** [2] 42, 44 (1937).—Methods and materials used to coat filter-press plates are described briefly, and their costs are compared. F.G.H.

Vapor-pressure humidostat and thermostat. E. B. WOOD. *Bell Lab. Record*, **16** [3] 102–104 (1937).—In many cases it is necessary to determine the effect of moisture on the operating characteristics and life of apparatus parts when used at different temperatures, since the properties of materials often vary widely depending upon their moisture content and temperature. Control over atmospheric conditions is accomplished in the Bell Laboratories by the use of a vapor-pressure humidostat and thermostat. The unique features of this apparatus are described. The instrument combines high sensitivity, reliability, and adaptability. Illustrated. P.S.D.

BOOK

Measuring Instruments in Industrial Work (Messgeräte im Industriebetrieb). G. WÜNSCH AND H. RÜHLE. Julius Springer, Berlin, 1936. 315 pp. Price 26.70 Rm. Reviewed in *Mech. Eng.*, **58** [7] 463 (1936).—This comprehensive review of industrial measuring instruments is intended for use as a textbook and as a guide for the commercial user. The general principles of measuring and recording apparatus are discussed in detail, and the special processes and instruments used for measuring pressures, temperatures, flow of fluids, contents of containers, and composition of gases are described. F.G.H.

PATENTS

Apparatus for breaking up mineral containing clay, loam, etc., by washing. C. M. J. A. F. NICOLAS. Brit. 477,776, Jan. 19, 1938 (July 3, 1936).

Centrifugal apparatus for separating and collecting dust or other solid particles from air and gases. C. H. W. CHELTNAM, C. H. CHELTNAM, W. H. LAKE, AND GENERAL ELECTRIC CO., LTD. Brit. 478,715, Feb. 2, 1938 (July 23, 1936).

Classification. A. C. MUNRO. U. S. 2,106,156, Jan. 25, 1938 (April 19, 1937).

Classifier. H. B. COULTER (Dorr Co., Inc.). U. S. 2,106,549, Jan. 25, 1938 (May 1, 1935; renewed Nov. 10, 1937).

Concentrator. A. C. MUNRO. U. S. 2,106,155, Jan. 25, 1938 (Juy 1, 1936).

Decorating apparatus. F. B. MCQUISTON (O. Hommel Co.). U. S. 2,107,491, Feb. 8, 1938 (Nov. 24, 1936). Apparatus for decorating a round object having a handle on its side comprises the combination of a printing device including a surface bearing a film of decorating material, the length of the film-bearing surface being substantially equal to the circumference of the object to be decorated less the breadth of the handle.

Drier for granular materials, etc. ENGELBERT FALKENSTEIN AND EMIL BARTHELMESS. U. S. 2,106,869, Feb. 1, 1938 (May 21, 1937). A method of drying granular and like material comprises the step of injecting the material substantially vertically upward into a counter-current of drying gas so that the material first travels upward under its own momentum counter to the gas current and then falls, traveling with the gas current.

Elevator classifier. A. C. MUNRO. U. S. 2,106,154, Jan. 25, 1938 (June 30, 1936; renewed Aug. 31, 1937).

Method and apparatus for separating gravel, etc. A. M. LOCKETT AND H. H. HOLLOWAY. U. S. 2,106,532, Jan. 25, 1938 (Nov. 20, 1933).

Pulverizer. E. G. BAILEY AND R. M. HARDGROVE (Babcock & Wilcox Co.). Can. 370,472, Dec. 14, 1937 (March 12, 1935; in U. S., March 23, 1934). G.M.H.

Pulverizer mill. H. R. COLLINS (Traylor Engineering & Mfg. Co.). Can. 371,027, Jan. 4, 1938 (Sept. 13, 1935; in U. S., Oct. 1, 1934). G.M.H.

Sandblasting mechanism. A. J. PONCELET. Can. 371,070, Jan. 4, 1938 (Jan. 9, 1936; in U. S., June 24, 1935). G.M.H.

Tile- and brick-making machines, etc. G. H. S. ELLIS (K. O. Forrer). Brit. 477,198, Jan. 7, 1938 (April 6, 1937).

Kilns, Furnaces, Fuels, and Combustion

Aërodynamics as a basis of modern fuel practice. P. O. ROSIN. *Jour. Inst. Fuel*, **9** [47] 287–98 (1936).—Aërodynamics is regarded as fundamental for the study of modern fuel technology. Air and gas currents play a decisive part not only in combustion and heating but also in many other branches of fuel technology. The essential point in experiments with models lies in producing a physical similarity between the industrial plant and the model. By means of experiments with models it is possible to demonstrate exactly what happens in cleaning processes, air separation, pneumatic transporting and dedusting, and streaming through fuel beds, pipes, furnaces, and heating ducts of boilers; this is possible even in cases where it is a question of currents of hot gases. Many examples show the part played by current phenomena in fuel utilization. Discoveries made in weeks with the model would, on a large scale, take years and cost enormous sums of money. H.E.S.

Artificial cooling of circular kilns. K. A. NOKHRATYAN. *Stroitel. Materialy*, **1937**, No. 8, pp. 1–10. P.B. & E.S.

Ash-softening temperature and ash composition in the utilization of coal. A. W. GAUGER. *Proc. Amer. Soc. Testing Materials*, **37** [Part II], 376–401 (1937).—G. discusses the influence of ash-softening temperature and ash composition on the tendency of a coal to clinker. R.A.H.

Charging green brick in circular brick kilns. M. M. NAUMOV. *Stroitel. Materialy*, **1937**, No. 8, pp. 10–12. P.B. & E.S.

Combustion control by means of electrical meters. V. BINNS AND S. BAIRSTOW. *Jour. Inst. Fuel*, **10** [50] 79–85 (1936).—The thermal-conductivity method of gas analysis is an accurate method of measuring the composition of flue gases when the appropriate corrections are applied to the meter readings. For boiler-plant control, a combination of an electrical carbon dioxide meter and a hydrogen meter is suggested as preferable to an oxygen meter. H.E.S.

Electric heating elements for high temperatures. W. TRINKS. *Ind. Heating*, **5** [1] 74–76 (1938).—The element

consists of a metallic core of sintered Mo which is protected from the oxidizing effect of air at temperatures higher than 1000°F by being encased in metallic oxides, chiefly Be oxide, and covered with an outer ceramic layer similar to sillimanite. The element can be used up to 3000°F. In operation, it resisted action by water vapor, H_2S, CO, and CO_2. M.H.

Friability and size stability tests on coal. R. E. Gilmore and J. H. H. Nicolls. *Proc. Amer. Soc. Testing Materials*, **37** [Part II], 421–40 (1937).—This paper deals primarily with the significance of the A.S.T.M. proposed methods of tumbler test for coal and drop-shatter test for coal. The testing of coals by the two methods is advisable in order to indicate the relative handling properties in respect to friability. The drop-shatter test serves for determining the resistance to breakage due to a lesser amount of handling as in the ordinary preparation and transportation of lump coal; the tumbler test serves for determining the liability to further breakage and ease of breakage when the coal is subjected to rougher handling as in mechanical conveyers, feed devices, crushers, etc. R.A.H.

Interpretation of laboratory coal tests. Proximate analysis and calorific value. G. B. Gould. *Proc. Amer. Soc. Testing Materials*, **37** [Part II], 342–68 (1937).—G. points out the difficulties involved in the interpretation of laboratory tests of calorific value, moisture, percentage of ash, volatile matter, and fixed carbon of coal. He also discusses tolerances in the interpretation of laboratory coal tests. R.A.H.

Lurgi process for complete gasification of coal with oxygen under pressure. H. C. Millett. *Jour. Inst. Fuel*, **10** [49] 15–21 (1936).—By effecting the gasification of lignite with oxygen and steam under pressures of 20 to 30 atmospheres, it is possible to obtain a gas which is comparable with normal town's gas in specific gravity, composition, and calorific value. Moreover, because of the high output of gas obtainable from a plant of relatively small size together with the high pressure of the gas produced and the economies realizable in the production of oxygen in large quantities, the process appears particularly suitable for the production of gas in large centralized units, preferably at places where cheap fuel is available. H.E.S.

Pulverizer performance as affected by grindability of coal and other factors. Martin Frisch and A. C. Foster. *Proc. Amer. Soc. Testing Materials*, **37** [Part II], 441–66 (1937).—Data are presented to show the relation between results of various laboratory methods for determining grindability and between grindability and commercial pulverizer performance. R.A.H.

Rotary electric kiln for decorated pottery. G. W. B. Electric Furnaces, Ltd. *Engineering*, **138** [3596] 645–46 (1934).—A rotary electric kiln for firing decorated pottery is illustrated and described. The kiln illustrated is capable of a maximum output of 3200 dozens of average dinner and tea ware per week, with an energy consumption of 2.10 kw.-hr./dozen, the loading being 55 kw. Larger sizes are available, having maximum capacities of 5000 dozens and 6700 dozens per week, respectively. The two larger sizes have loadings of 65 kw. and 75 kw., respectively, and the current consumptions are given as 1.97 kw.-hr. and 1.76 kw.-hr./dozen, respectively. A ventilator, with damper, of ample section is provided in the roof near the entrance, through which all size and oil fumes from the lithographs and colors are driven out of the chamber by air currents in the kiln. The advantages of the electric kiln are as follows: (1) the atmosphere in the kiln is clear and of an oxidizing nature, dust and sulfur being completely absent; (2) a uniform temperature can be maintained indefinitely; (3) the temperature is easily and conveniently controlled; (4) economy results from the fact that no labor is needed to tend the fires, remove ashes, etc.; (5) the cost of maintaining the refractories is greatly reduced; (6) the kiln is filled and emptied at the same point and no expensive trucks are required to handle the ware. H.E.S.

Significance to the consumer of sulfur in coal. Henry Kreisinger. *Proc. Amer. Soc. Testing Materials*, **37** [Part II], 369–75 (1937).—K. discusses in detail the effect of sulfur in coal on clinkering and slagging in the fuel bed, corrosion of metal parts in the furnace with which it comes in contact, and air pollution. R.A.H.

Special atmosphere furnace. W. F. Ross. *Wire & Wire Products*, **12** [8] 411, 446–47 (1937); abstracted in *Bull. Brit. Non-Ferrous Metals Research Assn.*, No. 102, p. 18 (Oct., 1937).—R. describes a furnace operated by the Riverside Metal Co. (N. J.) for the continuous annealing of brass, bronze, and nickel silver wire and strip. A controlled atmosphere is produced in a combustion-type generator from ordinary 530-B.t.u. gas and freed from sulfur and moisture. The furnace has automatic electrical heating and temperature control.

BULLETIN

Grindability of coals mined in the United States, Canada, and other countries. Anon. *Babcock & Wilcox Co. Bull.*, 32 pp.; reviewed in *Ceram. Age*, **29** [2] 58 (1937).—Tables of pulverizing characteristics and analyses of various coals are given. See "Check—," *Ceram. Abs.*, **15** [7] 216 (1936); "Determination—," *ibid.*, **16** [4] 123 (1937). F.G.H.

PATENTS

Building suspended arches and walls for furnaces and kilns, and refractory block or tile therefor. M. H. Detrick Co., Ltd. Brit. 477,131, Jan. 7, 1938 (Jan. 7, 1937).

Firing brick. T. B. Dreher. U. S. 2,107,146, Feb. 1, 1938 (Feb. 24, 1937). A method for producing black brick comprises cooling brick in a kiln from the firing high temperature to about one-half the firing high temperature, subjecting the cooled brick to an extended period of smoking, and then cooling the smoked brick quickly.

Means for supporting pottery and other goods during firing processes. W. E. Maddock. Brit. 477,486, Jan. 12, 1938 (Nov. 13, 1936).

Geology

Antimony as a raw material for the chemical industry. CHARLES HARDY. *Chem. Industries*, **38** [4] 363–65 (1936).—H. presents the uses and production figures of antimony. P.G.H.

Apparatus for testing bentonite or "imbibition bottle." MUNE UTIDA. *Jour. Japan. Ceram. Assn.*, **45** [533] 319–20 (1937).—A simple apparatus has been devised for a semiquantitative test of bentonite. The imbibition bottle is a graduated, long-necked, conical flask with a rubber stopper in which a slender glass pin, about 1 mm. thick, is inserted at the center. The inside dimensions of the bottle are diameter at bottom 30 mm., diameter of neck 8 mm., height of neck 22 mm., and total height 45 mm. Air-dry powder is pressed by hand in a metal mold 5 mm. wide and 10 mm. high; a tablet weighing about 0.2 g. is obtained. It is placed in the bottle at the center, water is slowly poured into the bottle to the base of the neck, and the bottle is left standing overnight. The pin keeps the tablet upright after it is expanded to about double height. Dispersed substance precipitates in the bottle and its final height or volume is read. The height or volume is the measure of the quality. The bottle is then shaken violently, inverted, and left standing, preferably overnight. Impurities will precipitate in the neck, forming layers. The amount and nature of the impurities can thus be determined. S.K.

Application of bentonite. JIROKICHI KUMAZAWA. *Jour. Japan. Ceram. Assn.*, **45** [532] 241–42 (1937).—The quality of bentonites can be estimated by the amount of impurities. K. has devised a practical method for their purification. Raw bentonite is mixed with a small amount of water and kneaded. The mass is put in a bag made of bleached cotton and the slip is squeezed out from the bag. The slip may be dried or dewatered by electrophoresis, but it is more convenient to use raw bentonites which contain only a small amount of mother rock and other impurities. Satisfactory porcelains were obtained by introducing 5 or 10% of the raw bentonite, produced in the Prefecture of Gunma or Hokkaido, to raw materials of several porcelain-producing districts. The batches were ground with water. Shaping was done by casting. After biscuit firing and glazing, bodies were fired to cone 9. S.K.

Bald Eagle magnesite mine, California. JOSEPH B. PERRY AND G. M. KIRWAN. *Amer. Inst. Mining Met. Engrs. Tech. Pub.*, No. 861, 15 pp. (1938); *Mining Tech.*, 2, No. 1 (1938).—This deposit was recently opened and has several interesting features. It is in southwestern Stanislaus County, 20 miles southwest of Gustine. A mass of débris collected on a hillside from serpentine rocks exposed to weathering; a landslide then occurred, and solutions from nearby serpentine rocks started to deposit magnesium carbonate in the breccia. This cemented the breccia, and further slides above the cemented layer opened more channels. The magnesite is the so-called amorphous variety and was deposited in middle Tertiary time. Due to the irregularities of the deposit, several different mining methods are used. Run-of-mine magnesite carries 2 to 2.75% SiO_2 and, by crushing and screening, fractions can be obtained with from 0.5 to 6% SiO_2. The plant is arranged so that several kinds of products such as dead-burned magnesite, artificial periclase, and various grades of calcined magnesite can be produced. W.D.F.

Bleaching clay: III, Behavior of oil constituents in the adsorption process. R. FUSSTEIG. *Petroleum Engr.*, **8** [13] 58, 62, 64 (1937).—The adsorption of all oil components by means of bleaching clay is considered from a practical standpoint. When using an excess of bleaching clay during the adsorption process, all components can be adsorbed. When the volume of bleaching clay is not sufficient to adsorb all impurities, only certain compounds will be removed. The complicated processes in equilibria that result from this phenomenon are not yet entirely investigated and explained. Viewing this phenomenon in the light of all theories and opinions discussed in this article, it is concluded that the different oil compounds are proportionally limited to the adsorbent when insufficient quantities of the adsorbent are used. The more readily a compound in the free state is adsorbed, the more readily it is adsorbed when mixed with other compounds. **IV, Characteristics of bleaching clay.** *Ibid.*, **9** [1] 85, 88, 90 (1937).—The most important property of bleaching clay is its adsorptive power. The other properties which are important to a lesser degree are fineness of grain, friability of the grains, types and amount of foreign material present in the clay, specific volume, and specific gravity. The optimum of all these properties is never found in one natural or artificially activated clay, and therefore many refiners prefer a mixture of several bleaching clays. **V, Classification of bleaching clay.** *Ibid.*, [3] 64, 66, 67.—Bleaching clays are divided into the artificial type, such as silica and alumina gel, and the natural type, such as fuller's earth, bentonite, and a recently discovered hydrosilicate of magnesium called Filtrol. The acid and alkali methods for increasing the adsorption power of natural clays are described in detail. **VI, Adsorption process in the percolation method.** *Ibid.*, [4] 80–82 (1938).—During the percolation adsorption process, oil is sucked into the bleaching clay at the moment of contact. The coloring material, such as acids and asphalt- and resin-like compounds, is quickly adsorbed to the interior of the microscopic channels. When the channels are filled with coloring matter the clay is exhausted and its adsorption power disappears. For the percolation adsorption process a clay should be tested for initial percolation efficiency, regeneration efficiency, characteristics in washing and steaming operation, and volume-weight relationship. For Parts **I–II** see *Ceram. Abs.*, **16** [6] 185 (1937). P.G.H.

By-product silica in new market. ANON. *Chem. Industries*, **41** [1] 40 (1937).—A new outlet for by-product silica is anticipated, due to the expanding market for glass products in industry and for construction. Feldspar producers are giving thought to the possibility of thus utilizing the large quantities of quartz that occur with feldspar in pegmatite dikes. A larger market for by-product quartz would cause development of froth flotation processes and encourage the exploitation of low-grade feldspar deposits. P.G.H.

Caolad flint. ANON. *Pottery Gaz.*, **63** [727] 87 (1938). Caolad flint is found in a deposit in southern Cork, Ireland.

It is a chalcedonic flint, occurs naturally in finely divided form, is consistent in color, and requires no calcination, only grinding. Its important characteristics for a pottery body are as follows: (1) it yields a clay which offers ease of working; (2) it gives added strength to the clay, both in the green and fired state; (3) because of the way in which it bonds up with other materials of the body and not because it contains any flux as compared with flint, it yields a body with an extraordinary bell-like ring. Economies can be effected in regard to the quantity which must be incorporated in a pottery body. E.J.V.

Chemical investigation of natural clays. W. F. Bradley. Read before Meeting of Chicago Section of American Chemical Society, April, 1937; abstracted in *Chem. Bull.*, **24** [5] 186 (1937).—Natural clays are not simple mixtures of kaolinite and allophane in varying proportions but often contain several distinct mineral species. The supplementary use of optical, chemical, and X-ray diffraction data in petrographic technique results in the identification of the individual components of such intimate mixtures normally containing from $^1/_4$ to $^3/_4$ by weight of particles below $^1/_4$ micron in size. W.H.G.

Chemical sand-washing plant. W. Jenkyn Thomas. *Mining Mag.*, **57**, 278–84 (1937).—Sand for the glass industry must contain less than 0.025% iron, but no economic process for removing the iron by washing has previously been developed. The iron can be removed in a solution containing $^1/_2$% oxalic acid plus some ferrosulfate, heated to 120°F. After a pilot plant was successfully operated, a full size plant was erected at Leziate, Norfolk. The sand is cleaned as well as possible by mechanical washing, thoroughly mixed with the oxalic acid and ferrosulfate solution, pumped into a rake-type classifier, and fed to a rotary filter. The solution is neutralized with caustic soda to precipitate the iron dissolved from the sand. The clear solution, without the iron, is regenerated with the addition of sodium oxalate and sulfuric acid. The sand is treated in another classifier and again filtered in order to remove the rest of the solution. It is taken by a belt conveyer to a storage floor, where it drains for 24 hr. and then loaded into trucks for shipment. W.D.F.

Chromite as a chemical raw material. R. H. Ridgway. *Chem. Industries*, **42** [1] 17–22 (1938).—R. describes the use of chromite in the ceramic, chemical, and metallurgical industries. See *Ceram. Abs.*, **17** [3] 106 (1938). P.G.H.

Classification of genetic types of graphite. N. P. Yakhontov. *Trudy Petrograf. Inst. Akad. Nauk S.S.S.R.*, **6**, 29–44 (1934); abstracted in *Chem. Zentr.*, **1937, ii**, 3295.—Graphite is classified according to the following factors: (1) variation in deposits, (2) type of material of origin (carbon), (3) type of mineral deposit, and (4) genesis of the given deposit. Y. discusses the possibility that graphite is formed by carbonates. M.V.C.

Cobalt and its compounds. C. More. *Argile*, No. 177, pp. 9–13 (1937).—M. describes in detail various cobalt compounds, their characteristics, and cobalt deposits. Cobalt is extensively used in the ceramic industry as a pigment for obtaining blue, pink, red, green, and yellow colors. M.V.C.

Colloidal properties of clay suspensions and gels: I. C. E. Reed. *Petroleum Engr.*, **9** [4] 48–50 (1938).—R. discusses the fundamental facts concerning behavior of clays from the standpoint of colloidal chemistry and X-ray analysis. P.G.H.

Commercial developments of beidellite clay. J. L. Essex. Read before Fifth Annual Illinois Mineral Industries Conference, Urbana, Ill., Oct., 1937; abstracted in *Chem. Industries*, **42** [1] 46–47 (1938).—A deposit of beidellite clay has been found in central Illinois which varies from 2 to 4 ft. in thickness and extends over a large area. The clay was found to have properties which make it suitable for rebonding, foundry molding sands, drilling oil wells, refining oils, de-inking newsprint, emulsifying oils, and coating pig-iron molds. It is quite possible that beidellite can be used wherever bentonite is required. P.G.H.

Composition and structure of stilpnomelane. John W. Gruner. *Amer. Mineralogist*, **22** [8] 912–25 (1937).—G. presents the chemical composition, dehydration and density determinations, and X-ray, base-exchange, and stability studies of a number of samples of stilpnomelane. F.J.Z.

Deflocculation and controlled separation improve domestic china clay. Fred E. Smith. *Chem. & Met. Eng.*, **44** [10] 594 (1937).—Due to the many fine qualities of the North Carolina clays and their availability to the American pottery centers, steps have been taken to clean these clays in order that they will be more adaptable to the pottery batches. The separation of the clays from the impurities of mica and sand is effected by deflocculation with sodium silicate. The crude clay is first ball milled with water and the deflocculant. The clay slip is then screened and classified and passed through a magnetic separator, after which the clay is concentrated in a thickener with the aid of a flocculating agent (alum solution). The thickened slip is then filter pressed and the cakes are dried and bagged, ready for shipment. Periodic tests and p_H determinations are made of the slip at various points in the operation in order that the best separation can be accomplished. M.C.S.

Densities and structural relationships of kaolins and anauxites. John W. Gruner. *Amer. Mineralogist*, **22** [7] 855–60 (1937).—Density observations on seven analyzed samples of anauxite and kaolinite made by G. do not seem to agree with Hendrick's conclusion (*Ceram. Abs.*, **16** [8] 256 (1937)) that the higher SiO_2:Al_2O_3 ratio in anauxite is due to the removal of Al^{3+} and OH^-, leaving a defective structure with holes. While anauxite seems to be slighty lower in density in two out of three cases, it is not very likely that the deficiency of Al can be explained satisfactorily in this manner. G. proposes a substitution of tetrahedral SiO_4 groups for octahedral $AlO_2(OH)_4$ groups. The loss of OH caused by this exchange is in as close agreement with analyses as can be expected. The method of density measurements by centrifuging in heavy liquids seems to give as accurate results as the use of the pycnometer if certain precautions are observed. F.J.Z.

Developments in filler clays. C. G. Albert. Presented at the Annual Meeting of the Technical Association of the Paper and Pulp Industry, 1937; abstracted in *Ceram. Age*, **30** [4] 120 (1937). F.G.H.

Diaspore in quartzite. Ernest L. Berg. *Amer.*

Mineralogist, **22** [8] 997–99 (1938).—A study of specimens of the Sioux quartzite from several localities in southwestern Minnesota and southeastern South Dakota shows that diaspore is an abundant and characteristic mineral of large portions of the formation. No similar occurrence is known. F.J.Z.

Glass sand enterprise on the Pacific coast. JOHN B. HUTTL. *Eng. Mining Jour.*, **138** [12] 29–31 (1937).—The Silica Company of Calif. is mining and processing flint and amber sands, silicate sand (98.5% SiO_2), and four grades of molding sand for steel foundries at its mine three miles southeast of Brentwood. All sands come from minerals mined underground. None of the sands has over 1.8% Al_2O_3. The mining and processing methods are described in detail. Illustrated. J.L.G.

Insulating material. BRITISH ZONOLITE PRODUCTS, LTD. *Foundry Trade Jour.*, **55** [1049] 232 (1936).—The advantages and properties of the various insulating products made from the mineral zonolite are described. H.E.S.

Magnesite in India. FRED LEBETER. *Mining Mag.*, **57**, 342–48 (1937).—The deposits cover 2000 to 3000 acres near Salem, 230 miles south of Madras. They occur in numerous hills, 60 to 100 ft. high, as veins in dunite and were formed by the decomposition of olivine. The deposits are worked by benches, usually 20 ft. high and 10 ft. broad. The deepest workings are 60 ft. below the level of the plain. The veins vary from 1 in. to 5 ft. in width and are not constant. In hard ground, dynamite is used and the magnesite separated by hand; in soft ground, the country rock is removed and the protruding vein broken down. The magnesite content of the rock is from 5 to 20%. It is calcined at 800° to 900°C to give lightly calcined magnesia or at 1600° to 1800°C to give dead-burned magnesia. Shaft kilns 60 ft. high and fired with producer gas are used. The first-grade lightly calcined magnesia is used with asbestos fiber to give "magnesia" compounds for insulation. The second-grade is used in magnesia cement and composition floors. Dead-burned magnesia is used in refractories, but little is made because it is so pure that iron oxide must be added to make the burning possible. W.D.F.

Mechanical and mineralogical subdivision of the clay separate of soils. E. TRUOG, J. R. TAYLOR, JR., R. W. SIMONSON, AND M. E. WEEKS. *Soil Sci. Soc. Amer., Proc.*, **1**, 175–79 (1936); *Chem. Abs.*, **31**, 8782 (1937).—Clay of particle size smaller than 2 μ from the *A* horizon of soils from humid climates contains few easily weathered mineral particles and consists almost entirely of materials highly resistant to further decomposition. Muscovite and quartz may still be present in primary or secondary forms. Such clays may be very reactive in fixation of K and P. After removal of organic matter, free iron oxides, and colloidal SiO_2 (see "Procedure—," this issue), the 2-μ clay can be further fractionated into coarse clay (2 to 0.2 μ) and fine clay (<0.2 μ). The fine clay contains nearly all of the base-exchange material and probably some quartz, muscovite, and other very stable minerals. The coarse clay has a low base-exchange capacity and is different chemically and physically from the fine clay. It probably consists of muscovite, quartz, talc, kaolinite, and other secondary minerals. The technique of separating the coarse and fine clay fractions is described.

Mica in argillaceous sediments. R. E. GRIM, R. H. BRAY, AND W. F. BRADLEY. *Amer. Mineralogist*, **22** [7] 813–29 (1937).—The determinations of the mineral composition of a variety of soils, clays, and shales, mostly from Illinois, have revealed in many of them a constituent, somewhat similar to muscovite, belonging to the mica group of minerals; it was formerly referred to as "sericite-like" material. By use of supercentrifuge fractionation technique, it is now possible to obtain this mineral in a relatively pure state, in certain fractions of colloidal size, from several shales, clays, and slightly weathered tills. The name "illite" is proposed for this material. Chemical, X-ray, optical, dehydration, and base-exchange data are presented and compared with similar data on other micas. F.J.Z.

Occurrence of detrital authigenic feldspar. DUNCAN STEWART, JR. *Amer. Mineralogist*, **22** [8] 1000–1003 (1937). F.J.Z.

Occurrences of kaolinite deposited from solution. W. A. TARR AND W. D. KELLER. *Amer. Mineralogist*, **22** [8] 933–35 (1937).—White powdery material found in various localities in Missouri has been shown by optical studies and X-ray analyses to be kaolinite and is proved by its mode of occurrence and crystalline character to have been deposited by solutions capable of its transportation. F.J.Z.

Physicochemical study of nacrite from Simferopol. H. S. NIKOGOSYAN. *Trudy Petrograf. Inst. Akad. Nauk S.S.S.R.*, **6**, 443–51 (1934); abstracted in *Chem. Zentr.*, **1937, ii**, 3443.—Chemical and thermal analysis of nacrite from Simferopol showed that it corresponds to the composition $Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$. Dehydration begins at 400° and ends at 500°. Thermal analysis and optical study show that the mineral investigated is probably nacrite rather than kaolinite. M.V.C.

Possible explanation for the occurrence of rolled pebbles in clay and bauxite deposits. L. M. RICHARD. *Bull. Amer. Ceram. Soc.*, **17** [2] 86 (1938).

Procedure for special type of mechanical and mineralogical soil analysis. E. TRUOG, J. R. TAYLOR, JR., R. W. PEARSON, M. E. WEEKS, AND R. W. SIMONSON. *Soil Sci. Soc. Amer., Proc.*, **1**, 101–12 (1936); *Chem. Abs.*, **31**, 6790 (1937).—After removal of organic matter with 10% H_2O_2, treatment of soil with Na_2S and oxalic acid under carefully controlled conditions of temperature and p_H rapidly dissolves free iron oxides and largely destroys the exchange capacity of the Fe-exchange complexes but has little effect on the Al-exchange materials. Examination of five soils showed an abundance of feldspar particles larger than 5 μ but only traces of the 2- to 3-μ size, indicating 2 μ as a desirable limit of separation between the unweathered silt and weathered clay materials. A procedure for removal of organic matter and iron oxides, complete dispersion of the soil, and mechanical analysis is described.

Production of potassium and ammonium from alunite. F. Y. LIU. *Jour. Chem. Eng. China*, **4**, 37–40 (1937); abstracted in *Chem. Zentr.*, **1937, ii**, 3360.—Alunite calcined at 550° or 600° yields a mixture of K_2SO_4 and $(NH_4)_2SO_4$ when treated with NH_3; the latter may be separated with lime. After eliminating NH_3, $CaSO_4$ separates from the sediment. The latter is boiled down and about 90% K_2SO_4 crystallizes. M.V.C.

Prospecting for beryllium ores. PAUL H. M. P. BRINTON. *Mining Jour.* [Phoenix], **21** [11] 5–6 (1937).—There has been much prospecting for beryllium materials because of their increasing industrial importance. Most of the compounds of beryllium, including beryl, are reviewed. Since beryl brings a low price at the mine, it is important to remember, while prospecting, that the proper accessory commercially valuable minerals, such as feldspar, mica, and quartz, should also be present. P.G.H.

Quantitative mineralogical composition of nepheline rocks. B. M. KUPLETSKIĬ AND T. M. OKNOVA. *Trudy Petrograf. Inst. Akad. Nauk S.S.S.R.*, **6**, 17–28 (1934); abstracted in *Chem. Zentr.*, **1937**, ii, 3295.—On the basis of numerous analyses, the mean composition of nepheline syenite, "iolite," and urtite was determined. The average composition (nepheline-feldspar) of nepheline syenite corresponds to the composition of nepheline-feldspar-pegmatite and granite. A classification of nepheline free from feldspar is recommended. M.V.C.

Refractory clays. R. LEDUC. *Argile*, No. 174, p. 13; No. 175, p. 13; No. 176, pp. 21–22; No. 177, pp. 5–7 (1937).—The composition, characteristics, and deposits of various refractory clays located in France are described. M.V.C.

Severite. V. CHARRIN. *Argile*, No. 177, pp. 3–5 (1937).—Severite is a special variety of clay of a creamy color which is related to the fuller's earth variety; mineralogically it is related to halloysite. C. discusses its deposits in France and its chemical composition. M.V.C.

Spodumene in North Carolina. ANON. *Bull. Amer. Ceram. Soc.*, **17** [2] 81–82 (1938).

Substitution of SiO_4^- and SO_4^- groups for PO_4^- groups in apatite structure; ellestadite, the end member. DUNCAN MCCONNELL. *Amer. Mineralogist*, **22** [8] 977–86 (1937). The apatite group is composed of a number of isomorphous series. The series apatite-wilkeite-ellestadite has been investigated in terms of both end members and two intermediate members. F.J.Z.

Talc deposits of North Carolina. JASPER L. STUCKEY. *Econ. Geol.*, **32** [8] 1009–18 (1937).—Talc deposits of lenticular shape and irregular size occur in association with the Murphy marble over a length of 40 miles in the southwestern corner of N. C. Field and microscopic evidence indicates that the talc lenses were formed by hot solutions of magmatic origin. Quartz-diorite dikes intruded in the rocks along either side of the marble belt seem to have been the source of the solutions. Minerals in the lenses are talc, tremolite, carbonates (calcite or dolomite), quartz, hornblende, actinolite, chlorite, and small amounts of pyrite and magnetite. Mining has been carried on for nearly 50 years by open pits and shallow shafts from a few feet to 40 or 50 ft. deep. See *Ceram. Abs.*, **14** [9] 230 (1935). J.L.G.

Thermal expansion of some clay minerals. J. F. HYSLOP AND A. MCMURDO. *Brit. Clayworker*, **46** [548] 329 (1937).—Expansion-contraction curves are given for English china clay, Missouri halloysite, Putnam beidellite, Maquoketa shale, and Fithian underclay. The curves for china clay and halloysite are very similar, the chief differences being the flattening of the china clay curve between 700° and 900°C and the cessation of contraction in the halloysite at 1000°C. The curve for beidellite shows progressive contraction from 200° to 900°C with accelerations at 420° and 800°C. The curves for the shale and underclay are in agreement up to 900°C. These clays expand to about 800°C and the underclay contracts rapidly thereafter, whereas the shale shows a sharp secondary expansion after contraction from 800° to 950°C. R.A.H.

Thixotropy of Japanese acid clay suspensions. B. TAMAMUSHI. *Kolloid-Z.*, **79** [3] 309–14 (1937).—T. investigated the thixotropy of suspensions of natural Japanese acid clays and compared his results with previous work on bentonite suspensions. A similar mutual relationship exists between thixotropy, relative swelling, lyophile coagulation, and plasticity of T.'s suspensions. F.P.P.

Tin as a chemical raw material. B. W. GONSER. *Chem. Industries*, **41** [1] 343–46; [5] 459–64 (1937).—G. presents the uses and production figures of tin and its compounds. P.G.H.

Trend of mineralogical research. W. A. TARR. *Amer. Mineralogist*, **22** [7] 869–71 (1937).—The attempt is made to determine the trend in mineralogical research by an analysis of the leading articles in *Amer. Mineralogist* and the *Mineralog. Mag.* for the last two decades. The material in the two journals is classified under several heads such as physical properties, crystal structure and X-rays, chemical mineralogy, origin, and descriptive mineralogy. The analysis reveals an interesting distribution of the subject matter and evidence of certain fairly definite trends. F.J.Z.

Unusual occurrence of halite. KIRIL SPIROFF. *Amer. Mineralogist*, **22** [8] 931–33 (1937). F.J.Z.

Yamagata bentonite: III, Imbibing behavior of cylindrical pieces of bentonite and its application to practical grading. MUNE UTIDA. *Jour. Japan. Ceram. Assn.*, **45** [531] 133–44 (1937).—U. proposes a new method of comparing the quality of bentonite. A small amount, *e.g.*, 0.15 to 0.30 g., of air-dried bentonite powder is pressed into a tablet. It is placed on a horizontal sheet glass, supported in a glass vessel, and is covered by a cover glass having a light vertical glass stem which penetrates a glass funnel held on the vessel. De-aired water is poured slowly into the vessel. In this way, imbibition of the tablet at both upper and lower ends is hindered. Imbibition begins at about 30 sec. and attains its maximum within 15 hr. The maximum linear imbibition is a measure of the purity of bentonite. Reliability of the test was confirmed. The relation between the maximum imbibition and load is shown by curves. A linear relation exists between percentage contents of pure bentonite in mixtures of pure bentonite and washing residue of raw bentonite and the maximum linear imbibition of the latter. The content of pure bentonite can be compared by means of the diagram. The value is called bentonite equivalent and is an index of the quality of bentonite. III (continued). *Ibid.*, [532] 200–206.—Experiments were made on the effects of shaping conditions, moisture, and kinds of bentonite on the maximum linear imbibition of the tablets. A definition and a method of classifying bentonites are proposed. The effect of the initial height of the tablets is negligible. The amounts of moisture in the air-dried tablets are in direct proportion to the contents of pure bentonite if the impuri-

ties are such substances as their washing residue, kaolin, and ignited silicic acid. The effect, however, is somewhat irregular for mixtures of purified bentonite and Japanese acid clays. The results of the experiments in which the tablets, made of 13 different bentonites and supported by rods, have been imbibed in water under no load indicate that bentonite substances as well as impurities are not always alike for different bentonites. U. proposes to classify bentonites by the proportion of the maximum linear imbibition and the rate of imbibing of the tablets and by the types of slaking and imbibition. According to U., bentonites are the products of decomposition of vitreous volcanic rocks, and their bentonite number of tablet imbibition test is 10 or more. Bentonite number = $h_o(h_m - 1)/W_o$, where h_o = initial height of tablet in mm., h_m = ratio of the maximum linear imbibition to h_o, and W_o = dry weight of tablet in g. For Part I see *Ceram. Abs.*, **17** [2] 83 (1938). S.K.

BOOKS AND BULLETINS

Beneficiation of spodumene by decrepitation. FOSTER FRAAS AND OLIVER C. RALSTON. *U. S. Bur. Mines Repts. Investigations*, No. 3336. 13 pp. Free.—An inexpensive process that may be used to treat spodumene to extract lithium compounds is described. See "Chloride—," *Ceram. Abs.*, **16** [10] 314 (1937). R.A.H.

Carolina kaolin. ANON. *Kaolin, Inc., Booklet*, 27 pp.; abstracted in *Ceram. Age*, **30** [4] 122 (1937).—A survey of the raw material resources and extensive refining facilities of this company at Spruce Pine, N. C., is presented. Illustrated. F.G.H.

Clay resources of the Tennessee Valley Authority region. ANON. *Tenn. State Div. Geol. Bull.*, No. 4, 32 pp.; abstracted in *Ceram. Age*, **30** [4] 121 (1937).—A detailed report on clay resources is given under the following divisions: (1) origin, distribution, and production of clay in the TVA region; (2) geology and kaolin deposits of Spruce Pine and Linville Falls Quadrangles, N. C.; and (3) clays of the western Tennessee Valley. See "Ceramics—," *Ceram. Abs.*, **15** [1] 37 (1936); "Spruce—," *ibid.*, p. 40. F.G.H.

Field Tests for Minerals. E. H. DAVIDSON. Chapman and Hall, Ltd., London, 1937. xiii + 60 pages. 12 plates. Reviewed in *Nature*, **140** [3550] 830 (1937).—Tests are given for all minerals the student or prospector is likely to find. J.L.G.

Flotation of langbeinite from the potash field of New Mexico and Texas. F. D. DEVANEY AND S. R. B. COOKE. *U. S. Bur. Mines Repts. Investigations*, No. 3300, 4 pp. (Feb., 1936). Free.—Langbeinite, $K_2SO_4 \cdot 2MgSO_4$, can be separated from halite by grinding to 100-mesh, conditioning with Avirol 80, and floating on brine saturated with NaCl, Na_2SO_4, and $MgSO_4$. High-grade concentrates (95%) with fair recovery (14%) were obtained. The separation is not unduly sensitive to small changes in amount of reagent, pulp consistency, or temperature. R.A.H.

Mineral Resources of Tennessee. ANON. *Tenn. State Div. Geol. Bull.*, 102 pp.; reviewed in *Ceram. Age*, **30** [4] 120 (1937).—A summary is given of the mineral products and resources of the state, including clays, feldspar, bentonite, talc, and other ceramic materials. F.G.H.

Mines Register, 1937. Vol. XIX. JOSEPH ZIMMERMAN, editor. Atlas Publishing Co., New York, 1937. 1340 + 282 pages. Price $25.00. Briefly reviewed in *Econ. Geol.*, **32** [8] 1067 (1937).—There are descriptions of 7500 mines in North and South America and other important foreign mining companies. An index of inactive mines, a section on metal statistics, and price ranges of major companies are given together with a glossary of mining terms; a section on mineralogy of ore minerals; a long list of mining officers, directors, and mining engineers; a directory of mining equipment; and lists of smelters and assay offices. J.L.G.

Vermiculite and bentonite in the Tennessee Valley region. ANON. *Tenn. State Div. Geol. Bull.*, No. 5, 51 pp.; reviewed in *Ceram. Age*, **30** [4] 120 (1937).—This survey and research is divided into six sections: (1) vermiculites of western N. C. and north Ga. (*Ceram. Abs.*, **14** [7] 172 (1935)); (2) research work on N. C. vermiculite; (3) bentonite of Miss.; (4) Ordovician metabentonites of the Tenn. Valley area; (5) metabentonites in the Chattanooga region; and (6) research work on bentonite and metabentonite. F.G.H.

MAP

Centennial Geological Map of Michigan. *Mich. Dept. Conservation, Geol. Survey Div., Geol. Series Pub.*, No. 39 (1937). 2 sheets. Price per set $1.50, southern peninsula $1.00, northern peninsula 50¢. Reviewed in *Bull. Amer. Assn. Petroleum Geologists*, **21** [12] 1600–1601 (1937). G.M.H.

Chemistry and Physics

Accelerated determination of aluminium, iron, and titanium in silicates. M. F. CHIGRIN. *Zavodskaya Lab.*, **6**, 758 (1937).—The silicate (0.1 g.) is fused with 1 g. of a mixture of fused B_2O_3 and $KNaCO_3$ (1:2); the melt is dissolved in aqueous HCl, and iron, aluminium, and titanium are precipitated by 10% ammonia. The filtered and washed oxide hydrates are dissolved in 0.2 *N* oxalic acid, the excess of which is titrated by 0.1 *N* NaOH with methyl red as indicator. An equal sample is dissolved in sulfuric acid, and iron and titanium are determined colorimetrically. The Al content is calculated therefrom. P.B. & E.S.

Application of "Wood's light" in the ceramic industry. MAURICE DÉRIBÉRÉ. *Argile*, No. 175, pp. 21–25; No. 176, pp. 7–11 (1937).—The principles of fluorescence are discussed. The phenomenon of fluorescence consists of a true transformation of energy. The body receives energy, absorbs certain rays, and reflects other rays of a different quality and always superior in wave-length to those of the existing source. The spectrum of the sun consists of a gamut of radiation: infra-red, visible spectrum, and ultraviolet. In the latter gamut, there is a region with a particular tendency to excite fluorescence. It is located between 2800 and 4200Å, with a maximum at 3660Å. R. W. Wood devised a special nickel glass which, when placed in front of a quartz Hg-vapor lamp, transmits rays

of a wave-length of 3650 to 3663Å only. These rays are called "Wood's light." Various types of lamps used at present are mentioned. The use of fluorescence to study the characteristics of certain glazes and in the examination of raw materials, control of fire and atmosphere in furnaces, and the study of ceramic bodies, physical properties, minerals, rocks, and slag is discussed. M.V.C.

β meta-alite. TOSHIYOSHI YAMAUCHI. *Jour. Japan. Ceram. Assn.*, **45** [532] 236–40 (1937).—In the experiment of the synthesis of tricalcium silicate by heating a mixture of 3 mol. of calcium carbonate and 1 mol. of silica for 2 hr. at 1800°C (S. Kondo and T. Yamauchi, *ibid.*, **41**, 552 (1933)), a cylindrical sample was heated by mistake at 1850° to 1900°. The product was vitrified and dissociated at the surface but was granular and undissociated inside. By chemical and microscopic examinations, α $2CaO \cdot SiO_2$ was detectable in the granular portion, but no free lime and no distinction between $3CaO \cdot SiO_2$ were found. X-ray analysis showed, however, that its lattice spacings were remarkably larger than those of $3CaO \cdot SiO_2$. In 1934 Solacolu discovered meta-alite (*Ceram. Abs.*, **15** [2] 54 (1936)). Y. proposes to call the latter α meta-alite and the former β meta-alite. X-ray analysis shows that α meta-alite is the $2CaO \cdot SiO_2$ form, while β meta-alite is the $3CaO \cdot SiO_2$ form. β meta-alite is a metamorphic compound of $3CaO \cdot SiO_2$ and is unstable. It is probable that when $3CaO \cdot SiO_2$ is heated, β meta-alite is produced first; it changes to α meta-alite and is finally dissociated. S.K.

Cadmium pigments in the glass, enamel, and ceramic industries. H. WELTE. *Emailwaren-Ind.*, **14** [40] 277–80 (1937).—Cadmium combined with sulfur yields a series of beautiful color tones from light yellow to dark orange. The reasons for coloring are not yet clearly known, but all the observed modifications of the pigment contain the composition CdS. The characteristics of CdS, its properties and effects in glasses and enamels, and its manufacture are discussed in detail. M.V.C.

Calculations of various physical constants of heterogeneous systems: II, Dielectric constants and conductivities of polycrystals of irregular systems. D. A. G. BRUGGEMAN. *Ann. Physik*, **25** [7] 645–71 (1936).—B. extends (mathematically) the theory (previously applied to isotropic substances) to polycrystalline systems resembling "mixed bodies" although actually of one phase. The new theory agrees satisfactorily with existing empirical data and succeeds in reconciling otherwise conflicting results. F.P.P.

Collation of experimental data: 46. A. ALISON. *Glass*, **14** [7] 289 (1937).—A. discusses the significance of the lag factor as evidence of correlation between the voltage and current of alternating current. **47.** *Ibid.*, [8] 331.—A discussion of (1) the coefficient of association and (2) the coefficient of contingency as they are used in making comparisons of two variable factors is presented. **48.** *Ibid.*, [9] 378.—A. discusses and explains the range of the coefficient of the mean square contingency. **49.** *Ibid.*, [10] 410.—Methods of determining and checking frequencies are discussed. **50.** *Ibid.*, [11] 461.—A. continues the discussion concerning the values of frequency studies and determinations. For Parts **42–45** see *Ceram. Abs.*, **17** [1] 46 (1938). M.C.S.

Colorimetric determination of silica and rapid analysis of corundum. F. YA. GALAKHOV. *Zavodskaya Lab.*, **6**, 1011–12 (1937).—The colorimetric determination of silica in corundum gives correct results only if the analytical conditions are strictly followed. Corundum (0.5 g.) is fused together with 4 g. of a mixture of potassium-sodium carbonate and fused borax (2:1). The fused mass is lixiviated with water containing exactly 9 ml. of H_2SO_4 (1:1). The solution obtained is poured into a 250 ml. flask. Silica is determined from 50 ml. of the solution with the aid of ammonium molybdate and picric acid as a colorimetric indicator. Iron oxides are determined by the usual colorimetric method after adding sulfuric acid to the solution. CaO is determined from the same solution by precipitating $R_2O_3 + TiO_2$ with ammonia. P.B. & E.S.

Contemporary advances in physics: XXX, Theory of magnetism. K. K. DARROW. *Bell System Tech. Jour.*, **15** [2] 224–47 (1936).—D. explains magnetism as ordinarily observed, the magnetization of pieces of matter of ordinary dimensions, by ascribing magnetic moment to the individual molecules, atoms, and electrons of which matter is composed. For Parts **XXVII–XXIX** see *Ceram. Abs.*, **15** [11] 347–48 (1936). H.E.S.

Determination of arsenic in ordinary and special steels and cast irons by the stannous chloride method. D. LOMBARDO. *Metallurgia Ital.*, **29** [1] 1–7 (1937).—L. presents a detailed study of Mazetti and Agostini's method of separating the As in elementary form with $SnCl_2$ and determining it iodimetrically and compares results by this method with the distillation and hypophosphorous acid procedures. The $SnCl_2$ method is found to be simpler and more rapid and is applicable in the presence of Cr, Ni, Co, V, Mo, Ti, Zr, Cu, Al, B, Mn, and W. F.P.P.

Determination of chromium in chromite. J. P. MEHLIG. *Jour. Chem. Education*, **13** [7] 324–25 (1936).—Chromite ore may be satisfactorily fused with sodium peroxide in a porcelain crucible if an outer crucible is used for protection. After the melt has been dissolved, it is not necessary to filter the ferric oxide-hydroxide residue before acidification of the chromate solution. The volume of the test solution at the start of the titration should be 200 cc., and the amount of sulfuric acid present must be carefully controlled. P.G.H.

Determination of hardness in water by direct titration. R. R. SHEEN AND C. A. NOLL. *Proc. Amer. Soc. Testing Materials*, **37** [Part II], 609–14 (1937).—Hardness in water may be determined by a direct titration with the potassium salt of certain fatty acids. Potassium stearate and potassium palmitate are of value, the palmitate allowing the more accurate determination in the presence of interfering ions. Comparisons are given with the standard soap on a number of samples, the results showing the palmitate method to be subject to less error. The more extensive use of the palmitate method is suggested. R.A.H.

Determination of limit of softening interval of the binary system $Na_2B_4O_7$–B_2O_3. A. A. LEONT'EVA. *Zhur. Fiz. Khim.*, **10**, 279–82 (1937).—The temperature, t_{sp}, for the system $Na_2B_4O_7$–B_2O_3 has been determined by investigating the elastic oscillations of the cooling melt. A sharp maximum of temperature for $Na_2O \cdot 3B_2O_3$ has been found.

Comparison with t_w measurements of viscosity showed that data obtained by both methods agree well.

P.B. & E.S.

Determination of MgO in acid-soluble slags. S. L. TSINBERG. *Zavodskaya Lab.*, **6**, 1008–1009 (1937).—Finely divided slag (0.5 g.) is dissolved in a mixture of 10 ml. HCl, 3 ml. HNO_3, and 5 ml. H_2O. After 3 to 4 min., the solution is diluted with warm water, and 2 g. of NH_4Cl, a little ammonia, and drops of bromine are added to oxidize the Mn present. After boiling until the odor of bromine disappears, the solution is poured into a 250-ml. flask, quickly cooled, diluted with water, mixed, and filtered. On the filter will remain iron, aluminium, and manganese hydroxides and a considerable part of silica. To 50 ml. of the solution are added 25 ml. of a 10% hot CH_3COONa solution and 20 ml. of a 10% hot NH_4Cl solution; to the boiling solution is added in excess a 2% alcohol oxine solution. Magnesium oxyquinolate is precipitated. The solution with the precipitate is filtered, and the precipitate is dissolved in 30 ml. of warm HCl (1:3); water is added up to 100 ml., and 1 g. KBr and the oxyquinolate are titrated as usual with 0.2 *N* $KBrO_3$, the excess of which is retitrated, after adding 5 ml. of a 20% KI solution, by 0.2 *N* $Na_2S_2O_3$ (1 ml. 0.2 *N* $KBrO_3$ corresponds to 0.001013 g. MgO). P.B. & E.S.

Determination of tin in ores and in metallurgical drosses by means of 0.1 normal potassium bromate. L. DEUTSCH. *Ann. Chim. Anal. Chim. Appl.*, **18** [1] 10 (1936).—Fuse 2 or 3 g. of the sample with 3 times its weight of Na_2O_2; after cooling, break up the fusion cake with H_2O and dilute HCl and then add more HCl until complete dissolution of the hydroxides; keep boiling for a while, transfer into a 500-ml. flask, add 5 g. of *ferrum reductum*, stir at intervals, and complete up to the mark with H_2O; filter and use an aliquot (100 ml.) for the determination of Sn; add 1 g. of pure Al (or Zn); close the flask with a suitable device provided with a hydraulic seal (solution of $NaHCO_3$); when the Sn is reduced to metal, add 60 ml. of HCl and dissolve the Sn by heating; then cool out of contact with air, allowing $NaHCO_3$ solution to flow into the flask when needed; to the cold solution add a small piece of marble and 15 ml. of indicator (solution containing 20 g. $ZnCl_2$ + 2 g. ZnI_2 + 4 g. starch per 120 ml. of H_2O) and titrate without delay. In alloy analysis, heat 2 g. of the sample in a flask with 20 ml. H_2SO_4 + 5 g. Na_2SO_4; allow to cool and add cautiously 100 ml. of H_2O and 30 ml. of HCl plus a few drops of methyl orange; warm the solution moderately and titrate the Sb with $KBrO_3$ (0.1 normal solution); transfer the solution into a 500-ml. flask, add *ferrum reductum*, and proceed as indicated above; 1 ml. $KBrO_3$ (0.1 *N* solution) = 0.00593 g. of Sn or 0.006 g. of Sb. In the latter case, both the Sb and the Sn are determined in the same solution and with the same reagent. R.W.D.

Diffusion of lithium ions through quartz in an electric field. P. M. HARRIS AND C. E. WARING. *Jour. Phys. Chem.*, **41** [8] 1077–85 (1937).—Measurable transport through quartz was obtained with potential drops of 5 to 125 volts, using anode-cathode materials of (Li, Hg–Hg), ($LiNO_3$–Hg), and ($LiNO_3$–NH_4HSO_4). Graphs of variation of current with time show that an initial conditioning period is necessary. A mathematical treatment is given which appears to substantiate the "tunnel" theory and which offers a method for investigating the kinetics of collision and attendant "free volume" in electrolytic solutions. C.J.P.

Dispersion of crystalline and fused quartz. J. ENGL. *Ann. Physik*, **25** [7] 600–608 (1936).—E. proposes a formula for the refractive dispersion of quartz in the visible and ultra-violet ranges. The formula successfully accommodates the most reliable experimental data currently available; below 5400 $\mu\mu$ the greatest deviation, *e.g.*, from Sosman's figures, is $\pm 7 \times 10^{-5}$ for crystalline quartz and $\pm 20 \times 10^{-5}$ for fused quartz. Above 5000 $\mu\mu$ the deviations increase. The tabulated values are discussed relative to dispersion and absorption data for CO_2 and O_2. F.P.P.

Electron diffraction—new tool for research. C. S. BARRETT. *Metal Progress*, **32** [5] 655–60 (1937).—Electron diffraction is being increasingly employed in metallurgical research. B. describes the diffraction phenomenon and briefly outlines its applications, *viz.*, in studying thin films on metals, corrosion and oxidation effects, diffusion rates, and polished surfaces. Several typical diffraction patterns are reproduced. F.P.P.

Elusive element No. 87 reported discovered. ANON. *Science News Letter*, **32** [868] 339 (1937).—Horia Hulubei, in France, has discovered the next to the last missing element, using a curved crystal focusing spectograph. The new element has been named madavium. P.G.H.

Equilibrium diagram of the system $CaO \cdot MgO \cdot 2SiO_2$–$MnO \cdot TiO_2$. USABURO NISIOKA. *Kinzoku-no-Kenkyu*, **14**, 138–40 (1937); abstracted in *Chem. Zentr.*, **1937**, ii, 3293.—The state diagram of the system diopside–pyrophanite was reproduced with chilled samples. A eutectic point occurs at 1183° and 48% $MnO \cdot TiO_2$. See *Ceram. Abs.*, **16** [5] 161 (1937). M.V.C.

Equilibrium relations and factors influencing their determination in the system K_2SiO_3–SiO_2. F. C. KRACEK, N. L. BOWEN, AND G. W. MOREY. *Jour. Phys. Chem.*, **41** [9] 1183–93 (1937).—Equilibrium relations at the liquidus of the system were reinvestigated, and the influence of absorbed moisture upon crystallization phenomena was studied. A study was also made of inversions in the crystalline compounds K_2SiO_3, $K_2Si_2O_5$, and $K_2Si_4O_9$. C.J.P.

Examination and correction of quartz plates cut perpendicular to the optical axis. ROGER SERVANT. *Rev. Optique*, **16** [6–7] 215–29 (1937).—Determination of the accuracy of inclination and correction to within 1 min. is possible by a method based on examination of the optical rings by converging light and of their displacement on turning the plate in its plane. F.P.P.

Grain-like structure of solids. WILLIAM BRAGG. *Nature*, **140** [3553] 954–56 (1937).—B. calls attention to the grain or fiber structure of solids whose units are too large for X-ray structure determinations and too small for microscope resolution, *e.g.*, the grain structure of metals, the fibrous structure of cellulose (whose fibrils consist of ellipsoidal objects 1.1 to 1.5 μ in size), the flakelike clay assemblages of colloidal dimensions, and the huge protein molecules. The structure of these large protein grains is now being worked out in terms of geometrical laws of distance and orientation. B. believes that similar work on other solids will ultimately resolve their intermediate or

"grain" structures. In the case of clay, such resolution would explain the way in which the particle of clay holds its associated water. J.L.G.

Helpful accessories in practical spectrographic analysis. J. S. OWENS. *Metals & Alloys*, **9** [1] 15–19 (1938).—O. describes four useful accessories: (1) purification of graphite electrodes by electrical heating to 2400°C in vacuum, (2) alignment pointer for the spectral source, (3) a.-c. arc spectral source, and (4) graphical plate calculator for conversion of microphotometer readings to percentage concentration. F.P.P.

Infra-red spectra of iron, titanium, and carbon. CARL C. KIESS. *Jour. Research Nat. Bur. Standards*, **20** [1] 33–37 (1938); R.P. 1062. Price 5¢.—New wave-lengths in the arc spectra of iron and titanium have been recorded photographically with the type *Z* plates produced by the Kodak Research Laboratories. Previously known lines in the spectrum of carbon have been photographed with high dispersion. R.A.H.

Interaction of sodium aluminate and silicate solutions. V. D. DYACHKOV. *Zhur. Priklad. Khim.*, **10**, 1211–15 (1937).—In the case of equal SiO_2 and Al_2O_3 contents, sodium silicate can stabilize and coagulate the aluminate solution independent of the concentration. The precipitates formed do not have a constant composition. The phenomena observed in the interaction of sodium aluminate and silicate are an indication of the colloidal nature of the sodium aluminate solution. P.B. & E.S.

Investigation of amorphous state. P. KOBEKO, E. KUVSHINSKIĬ, AND G. GUREVICH. *Tech. Phys. U.S.S.R.*, **4** [8] 622–37 (1937).—It is stated that the total mechanical deformation of amorphous bodies is composed of three independent components: (1) initial elastic deformation, (2) resilient highly elastic deformation, and (3) inelastic plastic deformation. The shearing moduli of several bodies, including phenolphthalein and hard and soft rubber, are given. The manifestation of highly elastic properties may take place at widely differing viscosities. See *Ceram. Abs.*, **16** [4] 114 (1937). C.J.P.

Investigation of the system TiO_2–SiO_2. D. BOGATZKIĬ. *Metallurg*, **1936**, No. 1, pp. 59–67; *Jour. Iron & Steel Inst.* [London], **136** [2] 68A (1937).—B. investigated the TiO_2–SiO_2 system and used the results to determine the composition of a silicotitanium which, when used as a deoxidizer in steel manufacture, will produce slags of the lowest melting point.

Mass production of science. ANON. *Ind. Bull. A. D. Little, Inc.*, No. 111 (1936).—The fact that mass production can be applied to research as successfully as to the manufacture of automobiles is demonstrated by recent work of G. R. Harrison at Mass. Inst. of Technology. There are ninety-two chemical elements, and each one, in an electrical discharge tube, emits light consisting of several thousand distinct colors. To each color of each element corresponds a number called the frequency which can be measured to within one part in ten million. Accurate values for these frequencies are useful in several branches of physics and chemistry. H. has constructed a machine which automatically measures the plates, makes the corrections, and photographs the numerical results to eight figures on a movie film. The average production exceeds ten thousand lines per day, requiring the time of five or six trained spectroscopists. The effect of these and similar developments will be to free individuals of the drudgery of detail, which at present forms more than 99% of the burden of research. H.E.S.

Measurement of particle sizes in clays. F. H. NORTON AND S. SPEIL. *Jour. Amer. Ceram. Soc.*, **21** [3] 89–97 (1938).

Method of estimating the finishing birefringence color of a crystal of random orientation in a thin section. R. VON HUENE. *Amer. Mineralogist*, **22** [8] 926–28 (1937). F.J.Z.

Microanalysis in the chemical laboratories. ANON. *Bell Lab. Record*, **15** [7] 232–33 (1937).—Sometimes it becomes necessary to determine the composition of precious-metal alloy contact points without removing enough material from the points to impair their operational functions as circuit elements. By means of eight excellent photographs, each supplemented with an inclusive explanatory caption, the microanalytical technique and procedure utilized by the Bell Laboratories for the determination of gold and silver in a relay contact point are outlined. P.S.D.

Permeability of fused silica in the extreme ultra-violet range. JEAN TERRIEN. *Rev. Optique*, **15** [8] 258–62 (1936).—Using a simplified photographic photometer method, T. measured the absorption coefficients in the extreme ultra-violet of various samples of fused silica. The wave-lengths for which the transmission of thin films (up to 3 microns) was 40% and 15% were measured: k = 60 at 1500Å and 1600 at 1460Å. Permeability was higher and more constant than had previously been indicated. F.P.P.

Quadrant-chart type nomograph applied to clay slips. J. A. PASK. *Jour. Amer. Ceram. Soc.*, **21** [3] 101–103 (1938).

Recent work on gels. H. FREUNDLICH. *Jour. Phys. Chem.*, **41** [7] 901–10 (1937).—F. briefly reviews the more important recent work on gels, including the jelly-like structures found with aluminum, iron, and silicon oxides, agar, gelatin, soaps, etc. 46 references. C.J.P.

Refractive indices and dispersions of volatile compounds of fluorine and boron. K. L. RAMASWAMY. *Proc. Indian Acad. Sci.*, **2**, 630–36 (1935).—The refractive indices and dispersions of carbon tetrafluoride, nitrogen trifluoride, fluoroform, nitrogen-carbon compound of fluorine, boron hexahydride, and nitrogenous boron hydride were measured at the ordinary temperature. The compressibilities of the gases mentioned were determined by studying the variation of refractive index with pressure. The atomic polarizations of these molecules were calculated from the dielectric and optical polarizations. R. found that the fluorine compound and the complex compound of boron have appreciable values of atomic polarizations. A.P.S.

Rhythmic crystallization in slags. F. ROLL. *Kolloid-Z.*, **79** [2] 221–22 (1937).—Periodic or rhythmic crystallization in slags is rare. R. presents macrophotographs of such bandlike crystal structures observed in cupola slags (53 SiO_2, 8 Al_2O_3, 14 Fe_2O_3, 6 Mn_3O_4, and 20% CaO) prepared under special cooling conditions in an iron foundry. Chemical analysis showed the amorphous and crystalline portions of the slag to be of slightly different composition,

the crystalline portion containing slightly more SiO_2 and Al_2O_3 and much less Fe_2O_3. F.P.P.

Spectrum analysis. ANON. *Ind. Bull. A. D. Little, Inc.*, No. 118 (1936).—The history of spectroscopic analysis is traced from the first discoveries of Isaac Newton to modern spectroscopy. Spectroscopic analysis is mainly of two types: (1) emission studies, where the substance under investigation is vaporized and made to emit light indicating the types of atoms present in the sample, and (2) absorption studies, where light is passed through the vapor or the solution of the sample before it enters the spectrograph, yielding information about the molecular structure of the compounds present. Chemical analysis is supplanted by spectrographic methods in cases where (*a*) only a very small sample is available, (*b*) the percentage of the element under study is small, (*c*) information about a series of elements present is needed quickly, and (*d*) chemical procedures are difficult or unreliable. Spectroscopic control is being used in the production of chemicals, medicinals, foods, and metallurgical products. H.E.S.

Spectrum-analytical investigations for industrial laboratories. R. RAMB. *Metallwirtschaft*, **16** [43] 1102–1107 (1937).—Methods for qualitative and quantitative detection of elements are described. M.H.

Study on the celite part: I, System CaO–Fe_2O_3. TOSHIYOSHI YAMAUCHI. *Jour. Japan. Ceram. Assn.*, **45** [533] 279–99 (1937).—A study has been started on the celite part of Portland cement, its chief object being to determine whether or not brownmillerite, $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$, exists. An exact knowledge of lime, ferric oxide, the system lime–alumina, and the system lime–ferric oxide is necessary. The system lime–alumina has been reported several times (S. Kondo and T. Yamauchi, *Ceram. Abs.*, **16** [3] 82 (1937)). Y. deals with the remaining three items. It has been verified by X-ray methods that there is no variation in the crystal structure of lime heated at 1100° to 1500°C. Chemically pure ferric oxide was heated at 950° to 1360°C to estimate its thermal dissociation, and the solubility of the raw and heated samples in dilute HCl and their interplanar distances, d_{hkl}, were compared. Results are as follows: (1) the loss on heating is negligible though it increases with a rise of temperature at 1100° and up; (2) there is no difference among the heated samples in their solubility in 2 *N* and more dilute HCl; and (3) X-ray analysis shows no effect of heating. It is probable that the dissociation takes place only at the surface of the grain. Four mixtures of $CaCO_3$ and Fe_2O_3 in molecular ratios of 3:1, 2:1, 1:1, and 1:2 were heated at 900° to 1470° for 2 or 3 hr. and cooled slowly or quenched; melts were reheated at lower temperatures for 24 to 120 hr. Every sample thus obtained was examined for microstructure and X-ray diffraction. Only two compounds, $2CaO \cdot Fe_2O_3$ and $CaO \cdot Fe_2O_3$, were found in the system lime–ferric oxide. Y. discovered that dicalcium ferrite forms solid solutions, with some percentages of lime, which dissociate at their melting points. The mixture $3CaCO_3 + Fe_2O_3$ heated at 1200° to 1400° and the same mixture melted at 1470° showed the presence of free lime in microscopic and White's solution tests. Free lime was detected only in the melted sample by X-ray analysis. Samples heated at 1200° to 1400° gave diffraction patterns apparently similar to those of dicalcium ferrite. Interplanar distances, *d*, of the former, however, were reduced with a rise in the heating temperature. The solid solution seems to begin the dissociation at about 1400°. The hydration of the calcium ferrites is described. Monocalcium ferrite indicated no evidence of hydration in microscopic and X-ray examinations. The hydration of dicalcium ferrite has been obscure microscopically even after two years. X-ray analysis of the sample sealed with an equal amount of water and aged at 20°, however, indicated that in 20 days the pattern of the original compound had disappeared and a quite different pattern had appeared. The clove-oil test under the microscope, the thermobalance test, and thermal analysis failed to show the presence of calcium hydroxide in the hydrate. Hydrated ferric oxide was not found under the microscope. By determination of the combined water, Y. gave a chemical formula, $2CaO \cdot Fe_2O_3 \cdot 5H_2O$, to the hydrate. **II, Brownmillerite.** *Ibid.*, [534] 361–73.—Microscopic and X-ray examinations were made on vitrified and melted samples of five mixtures with chemical formulas of $3CaO \cdot Al_2O_3 \cdot Fe_2O_3$, $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$, $5CaO \cdot Al_2O_3 \cdot Fe_2O_3$, $6CaO \cdot Al_2O_3 \cdot 2Fe_2O_3$, and $6CaO \cdot 2Al_2O_3 \cdot Fe_2O_3$. Results may be abridged as follows: (1) Each fired sample consists of 1 to 3 different crystals, and the principal mineral forming the whole or main part of every sample is a compound or probably a solid solution of ferric oxide type which is reddish brown and fibrous and has a strong double refraction and a high refractive index. (2) The principal minerals have zonal structure. (3) All samples give diffraction patterns of $2CaO \cdot Fe_2O_3$ type, and the principal minerals seem to have an internal structure of a strictly similar type which is different in the interplanar spacing of the lattice. (4) The lattice spacing of the fired sample of $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$ is the same as that of brownmillerite reported by many scientists. (5) The lattice spacing decreases in the order of $2CaO \cdot Fe_2O_3$, $6CaO \cdot Al_2O_3 \cdot 2Fe_2O_3$, $3CaO \cdot Al_2O_3 \cdot Fe_2O_3$, $5CaO \cdot Al_2O_3 \cdot Fe_2O_3$, $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$, and $6CaO \cdot 2Al_2O_3 \cdot Fe_2O_3$, indicating that their principal minerals lie in a series of solid solutions. The principal mineral of $6CaO \cdot 2Al_2O_3 \cdot Fe_2O_3$ seems to be the solid solution of the greatest miscibility and resembles a compound more than brownmillerite does. (6) In the principal minerals of the fired mixtures which are richer in lime than $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$, the contents of lime and alumina are reduced with an increase of lime in the mixtures. (7) The fired sample of $5CaO \cdot Al_2O_3 \cdot Fe_2O_3$ contains graniform free lime, $3CaO \cdot Al_2O_3$, and a compound or probably a solid solution of ferric oxide type which has less lime and alumina than $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$. Accordingly, in high-lime special cements whose molecular ratio of alumina to ferric oxide is 1, the ferric compound seems to exist as a solid solution whose contents of lime and alumina are lower than those of $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$. S.K.

Tensile strength and elasticity of quartz fibers. O. REINKOBER. *Physik. Z.*, **38** [4] 112–22 (1937).—Etching the surface increases the tensile strength and, to a lesser degree, the elastic limit of quartz fibers. There is a minimum thickness of surface that must be removed before maximum strength is reached; excessively protracted etching, however, will cause a reversion to the original lower tensile strength. If the tensile strength is measured with the etchant (HF) still on the surface, only a slight increase is observed. Adsorbed surface films lower the

tensile strength. The latter is increased, however, by removing the film with vacuum heating; no significant effect of such treatment on the elastic modulus was observed. The adsorbed layers alone are not capable of reducing the tensile strength, but do so through joint action with a surface film of the quartz itself. Measurements of bending strength showed that surface irregularities tend to increase bending resistance with decreasing fiber thickness. F.P.P.

Viscosity and Reynold's number. J. R. ZWICKL. *Refrig. Eng.*, **33** [6] 389–93 (1937).—Z. attempts to clear up the relation which exists between the different units commonly used for expressing the viscosity of a fluid. These units, the relation between their individual magnitudes, and the relation between the different viscosity numbers which express the same case of viscosity but in terms of the different units are given in tables. P.G.H.

BOOKS

Comprehensive Treatise on Inorganic and Theoretical Chemistry: Vol. 16, Pt and General Index. J. W. MELLOR. Longmans, Green & Co., London, 1937. Price 3 guineas. Two supplementary volumes dealing with recent developments and a third volume on the borderland between organic and inorganic chemistry will complete this monumental work. For Vol. 15 see *Ceram. Abs.*, **16** [3] 102 (1937). H.H.S.

Gravimetric Analysis: a Laboratory Manual with Special Reference to the Analysis of Natural Minerals and Rocks. W. VAN TONGEREN. H. K. Lewis and Co., Ltd., London, 1937. xi + 278 pp. Price 14s net. Reviewed in *Nature*, **140** [3546] 665 (1937).—A critical description of modern gravimetric methods with especial attention to geochemical principles is presented. J.L.G.

Reactivity of Solids (Reaktionsfähigkeit fester Stoffe). J. A. HEDVALL. Verlag Johann Ambrosius Barth, Leipzig, 1938. 243 pp., 50 illustrations. Price 18 Rm. paper; 19.20 Rm. cloth. The ancient dictum of Aristotle that *corpora non agunt nisi liquida*, which means that only liquids can react, is quite wrong, since even in solids the atoms are in motion. Due, however, to the slow diffusion velocity of atoms through the layer of reaction product, reactions of solids at low temperature are almost brought to a stop. For this reason, such reactions have not been commonly recognized except by students of high-temperature phenomena.

H., who has, by his numerous researches, made himself an authority in this field, points out that the weaker the forces holding the particles in their lattices, the more easily will reactions occur, and every factor which weakens these forces will enhance the reactivity.

The book is divided into three parts. The first, which covers about one-fourth of the work, is concerned with the fundamental principles of crystal structure and with their relation to chemical composition. These developments have been of the greatest significance in the understanding of solid phase reactions. The various lattice types, ionic, molecular, metallic, layer, etc., are described and illustrated. The principles of polymorphism are discussed. A section is devoted to lattice energies and to lattice vibrations with their characteristic frequencies. An important discussion is given of surface properties of solids, in regard to recrystallization processes and to catalytic effects on mixed-oxide catalysts.

If the reader is already familiar with the general principles of crystal chemistry, he will undoubtedly find the second part of the book the most instructive. This covers more than one-half the book. The historical developments in the subject of reactivity of solids are treated, and attention is given to experimental methods and to the deduction of the underlying principles. A systematic treatment is given of reactions involving ionic interchange (Platzwechselreaktionen) for bivalent oxides with sulfates, carbonates, phosphates, and silicates. The quantitative study of rates of gas-forming reactions by Braune, Jander, Fishbeck, and others is discussed. The pioneering work of Hüttig on the nature of intermediate phases is described in detail. The important studies of Hevesy, Phipps, Biltz, and others on electric conductivity and on diffusion in solids are presented and discussed to show the factors which determine ionic mobility in solids. The rôles of polymorphic change, radiation, etc., in loosening the lattice and permitting greater ease of atomic movement are described. The past history of an oxide, *e.g.*, whether formed from sulfate or carbonate, is shown to have great effect on its properties. Some discussion is given of fluorescence and phosphorescence.

The third part of the book should be of special value to ceramic and metallurgical workers. Reactions of glass-melting and properties of certain refractories and of certain calcined oxide colors are discussed. Attention is given to the thermal properties of clays, chromite, dolomite, and other minerals. Sintering and grain growth in metal powders and catalysis of certain reactions by gas or liquid are also discussed.

This book marks a definite step forward in its field, for it brings together and treats systematically the observations and theories which have hitherto been scattered through many scientific journals. The book is well documented with literature references. Every worker who deals with the heat treatment of inorganic materials will find it full of stimulating ideas and concepts. NELSON W. TAYLOR

Renaissance of Physics. K. K. DARROW. Macmillan Co., New York. Briefly reviewed in *Bell Lab. Record*, **15** [4] 133 (1936). P.S.D.

Thorpe's Dictionary of Applied Chemistry: Vol. I, A–Bi. 4th ed. JOCELYN F. THORPE AND M. A. WHITELEY. Longmans, Green & Co., New York, 1937. xxvii + 703 pp. Reviewed in *Nature*, **140** [3556] 1066–67 (1937); see *Ceram. Abs.*, **15** [9] 289 (1936). J.L.G.

PATENTS

Making alkali subsilicates. PENNSYLVANIA SALT MFG. CO., LTD. Brit. 477,578, Jan. 12, 1938 (April 10, 1935).

Zirconia. SOC. ANON. DES MANUFACTURES DES GLACES & PRODUITS CHIMIQUES DE ST. GOBAIN, CHAUNY & CIREY. Ger. 647,918, July 16, 1937; Cl. 12*m*. 9; *Chem. Abs.*, **31**, 8131 (1937).—Crystallized ZrO_2 is prepared by fusing Zr, cooling and grinding the resulting mass, and treating it with HF solution.

General

Adhesive and caulking material. RIVERTEX CORP. *Chem. Industries*, **38** [2] 149 (1936).—A rubber latex base adhesive called Plasoleum which can be mixed on the job and applied cold is used for laying tile and glass on concrete, wood, brick, and plaster walls. P.G.H.

Centenary of an Australian pottery. THOMAS CAMPBELL. *Clay Prod. Jour. Australia*, **5** [2] 9–11 (1937).—The R. Fowler, Ltd., pottery, now at Marrickville, Sydney, was founded by Enoch Fowler in 1837. A grandson and two great-grandsons are still in the firm. Fowler ware includes everything from 24-in. pipes to delicate teapots and vases. A branch factory at Thomastown, Melbourne, was founded in 1927. H.H.S.

Cesco respirator. CHICAGO EYE SHIELD CO. *Mining Jour.* [Phoenix], **20** [21] 46 (1937).—A respirator used for filtering dust is described. P.G.H.

Dust prevention in the refractory industry. RADEMACHER. *Feuerungstechnik*, **25**, 132–33 (1937); *Brit. Chem. Abs.–B*, **56**, 913 (1937).—R. describes methods employed in SiO_2 brick factories to prevent escape of SiO_2 dust into the atmosphere.

Engineers and economics. MORRIS E. LEEDS. *Elec. Eng.*, **56** [2] 206–207, 215 (1937).—L. discusses the characteristics of engineering that should give the engineer a stronger sense of economic and social responsibility than is sometimes felt by those in other professions. He suggests that an engineering approach should be made to economic problems. P.G.H.

Evaluation of plasticity. A. E. DODD. *Refrac. Jour.*, **13** [9] 573 (1937).—D. briefly reviews methods of determining and evaluating plasticity values. The methods are divided into two classes: (1) the absolute, involving the measurement of two properties; and (2) the derived, where two factors are resolved into one figure. M.C.S.

Hydraulic stripping of a stone quarry. MARK SHEPPARD. *Amer. Inst. Mining Met. Engrs. Tech. Pub.*, No. 879, 8 pp. (1938); *Mining Tech.*, **2**, No. 1 (1938).—A West Virginia quarry is in a 200-ft. thick bed of limestone. The top of the stone is cut by erosion channels up to 30 ft. deep and 8 ft. wide, with overburden ranging in thickness from a few inches to 10 ft. As the cost of hand labor for removing this was too high, hydraulicking was tried. Water is pumped from the river by a 200-h.p., four-stage, centrifugal pump, through 8- and 4-in. pipe, to a point 300 ft. above the river. Using two monitors, 1 in. and $^3/_4$ in., gave the best results. The waste is carried in launders across the quarry and into the river. The hydraulicking is done only during the period of high water, from October to April. The cost is $1.16/cu. yd. of dirt removed. W.D.F.

Karcite—a new ceramic material for laboratory equipment. STUART M. PHELPS AND EDWARD E. MARBAKER. *Jour. Amer. Ceram. Soc.*, **21** [3] 108–11 (1938).

Machine tests silicosis sufferers. ANON. *Stone*, **58** [12] 470 (1937).—A machine called an ergometer has been developed at the Rochester Medical School. The person to be tested rides a bicycle-type apparatus equipped with electromagnet brakes. Expired breathing passes through the valve of a recording spirometer. Increased expiration is greatest in persons afflicted by a dust disease. P.G.H.

Mineralogical and physical properties of rocks and their dusts as sources of danger in the stone-producing and stone-working industries. G. HASS. *Zentr. Gewerbehyg. & Unfallverhüt.*, **24**, 193–201 (Sept., 1937).—Experts who deal with the problems of silicosis need much scientific information derived from other specialties besides their own. Accordingly, H. has compiled and organized for ready reference basic facts from 22 minerals technically important in the rock-products industries. All the work done in obtaining and elaborating these raw mineral materials produces dust harmful or dangerous for the workers to breathe. H. separately describes or comments upon these 22 minerals or mineral groups. The facts are given in a table with 12 subdivisions including the mineral's name or names, chemical formula, percentage of SiO_2, crystalline form, density, hardness, cleavage, elasticity, structure (fibrous, scaly, etc.), weathering, forms encountered, distribution, and the industries employing these minerals. The ceramic industries use six of these rock compounds, *viz.*, various types of quartz, chalcedony, potash feldspar (orthoclase and microcline), talc, steatite, and kaolin. K.R.

Nonmetallics in the chemical industry. F. A. ROHRMAN. *Jour. Chem. Education*, **14** [8] 353–59 (1937).—R. describes and illustrates the industrial uses of glass and glass-lined products, chemical stoneware, heat- and acid-resisting brick, and fused silica. P.G.H.

Physical aspects of the silicosis problem. A. J. LANZA. *Amer. Inst. Mining Met. Engrs. Tech. Pub.*, No. 856, 4 pp. (1937); *Mining Tech.*, **1**, No. 6 (1937).—There are no inherent qualities which predispose to silicosis. Preëxistent tuberculosis aggravates and hastens the development of silicosis, and silicosis predisposes to tuberculosis. A safe limit of dustiness has not been absolutely determined, but over 5 million particles/cu. ft. of highly siliceous dust is dangerous. Medical inspection of the men exposed should be made, along with engineering control of the dust. See "When—," *Ceram. Abs.*, **16** [2] 77 (1937). W.D.F.

Properties of silicate paints for concrete. ANON. *Chem. Industries*, **39** [5] 511–12 (1936).—Cement necessitates a very special paint which must approach as nearly as possible that of the surface which is to be painted, so that homogeneity is obtained between the paint and the covered surface. For this purpose, paints are used with a basis of liquid silicates. Under the action of the CO_2 of the air, the silicate forms into a hydrated potash or sodium carbonate and amorphous silica. $K_2O, 4SiO_2 + CO_2 = K_2CO_3 + 4SiO_2$. A part of the amorphous silica recombines later with the carbonate to form a monosilicate. $K_2CO_3 + SiO_2 = K_2SiO_3 + CO_2$. The silicate paint may be colored by combining with inorganic pigments and should be applied at between 20° to 25°Bé. P.G.H.

BOOKS AND BULLETINS

Ceramic engineering as a career. ANON. Institute for Research, Chicago, 1937. 24 pp. Price $1.00. This brochure is a well-printed, well-illustrated, and well-composed exposition of ceramic engineering. The scope and definition of ceramics are given, and the educational

training needed for and the possible employment in the ceramic industries are discussed. Names and addresses of ceramic schools, trade associatons, technical societies, and trade papers are listed. It is a valuable booklet for any person seeking information on ceramics as a career.

R.C.PURDY

Crystal gazing. ANON. *Ind. Bul'. A. D. Little, Inc.*, No. 119 (1936).—The centennial celebration of the American patent system in Washington is discussed. The patent system of this country, the American capacity for inventiveness, and the ability to translate inventions into significant industrial activity form a combination of three interdependent factors predominantly responsible for our present advancement and high standard of living. Future patent system policies should be determined with full regard for the interdependence of these factors, the absence of any one of which would largely destroy the effectiveness of the others. The two closely related factors, inventiveness and the industrial development of inventions, must be encouraged for the general good.

H.E.S.

Drilling Mud: Its Manufacture and Testing. P. EVANS AND A. REID. *Trans. Mining & Geol. Inst. India*, **32**, 263 pp. (Dec., 1936). Price 19s 6d.—Although dealing wholly with clays used for the preparation of rotary "drilling mud" (as a mixture of clay and water is termed in the oil industry), the methods employed and the results obtained are of interest to ceramic workers as their problems are very similar to those discussed. The authors discuss viscometers used for measurements on mud fluids and describe those employed in America, India, and elsewhere. For routine work in Burma and India, a paddle viscometer has been extensively used; in this, the force needed to rotate a small paddle immersed in the mud is measured by placing weights on a scale pan. Difficulties in operating the various viscometers are dealt with briefly, with frequent references to the relevant literature. Various factors affecting viscosity are illustrated by reference to actual examples of measurements by the authors and their colleagues. An attempt is made to indicate lines on which it might be possible to relate the physical properties of the mud to the pressures needed in the pumps which force the mud through the circulating system of the well. Other tests made on mud are more briefly discussed. Salinity tests (to determine the amount of salt in the mud) aid in the detection of small inflows of saline water from the formations drilled through. Stability tests are very important, as unstable muds may lead to almost endless troubles in drilling. The amount of sand carried by a mud should be a minimum in order to reduce wear and tear on pump parts, and frequent checks on the sand content are recommended. Size of the particles composing the mud, colloid content, plastering power, plasticity, and various other properties are considered. Plastering power is an important but little-understood property which bears on one of the important functions of the mud—the building up of a sheath of clay on the surface of the formations drilled through. Emphasis is laid on the graphical presentation of experimental results. The references are drawn from a wide range, and the detailed lists of contents and the full indexes make it easy to turn to any of the subjects dealt with. The paper shows how apparently minor technical details of an industry may give rise to prolonged scientific investigations. Illustrated. See "Rotary—," *Ceram. Abs.*, **15** [7] 214 (1936). A.P.SOM.

Fundamental research. C. M. A. STINE. Read before Chem. Eng. Congress, London, 1936; abstracted in *Ind. Bull. A. D. Little, Inc.*, No. 116 (1936).—Fundamental research is a quest after facts concerning properties and behavior of matter, without regard to specific application of the facts discovered. S. believes that, from fundamental research, industry can (1) provide a basis for future processes and products, (2) solve the more difficult or complex "practical" problems by other than empirical methods, (3) assure continued leadership in quality and economy of production by unremitting study of existing products and processes, (4) create within an industry specialists who are available for consultation, (5) broaden and strengthen relations between industry and the university research workers, (6) attract to an industry those university graduates who have a distinct aptitude for research, and (7) provide an outlet within an industry for workers in applied research who develop a distinct aptitude for fundamental research. S. also emphasizes the importance of a sympathetic administrative attitude. H.E.S.

Industrial Dust. P. DRINKER AND T. HATCH. McGraw-Hill Book Co., New York, 1936. 316 pp. Price $4.00. Reviewed in *Mech. Eng.*, **58** [11] 749 (1936).—The authors discuss phases of the problem of dust control in its relation to the health of workmen, emphasizing the coöperative nature of the problem as one for both engineers and physicians, and presenting principles and methods for designing and operating dust-control equipment. The physical aspects of dust and fume suspensions and their effect upon man; the analysis, measurements, and microscopy of fine dusts; the practical control of dusts; and the use of dust respirators are considered. F.G.H.

Review of Literature on Effects of Breathing Dusts with Special Reference to Silicosis. D. HARRINGTON AND SARA J. DAVENPORT. *U. S. Bur. Mines Bull.*, No. 400. 305 pp. Price 25¢ from Supt. of Documents, Govt. Printing Office, Washington, D. C. Information on effects of breathing dusts, largely in the mining and allied industries, is given. Outstanding data on several aspects of the subjects, especially with reference to silicosis, are assembled. See *Ceram. Abs.*, **16** [3] 104 (1937). R.A.HEINDL

Sprechsaal Yearbook, 1937 (Sprechsaal - Kalender, 1937). ANON. Müller and Schmidt, Coburg, 1937. 406 pp. Price 2.50 Rm. Reviewed in *Ceram. Age*, **30** [4] 118 (1937).—The first part of the book is arranged in diary form. The second section is devoted to ceramic technical information, including standard tables, detailed data, and charts on topics of everyday utility in the field. There is a classified product guide concluding the volume, listing the materials or equipment of advertisers under their respective heads. F.G.H.

Subject Index to Periodicals, 1936. Edited by T. ROWLAND POWEL. Library Association, London, 1937. xii + 300 pp. Price 70s. Reviewed in *Nature*, **140** [3546] 665 (1937).—The 1936 index contains references to over 27,000 articles from 597 periodicals; 547 of these are American and English journals. J.L.G.

Technological aspects of patents. ANON. *Ind. Bull. A. D. Little, Inc.*, No. 112 (1936).—The patent functions of

A. D. Little, Inc., are (1) coöperation with patent attorneys and inventors in broadening the scope of an invention beyond particular features originally disclosed, (2) cooperation in preparing and presenting expert testimony for patent litigation, (3) conducting investigations of processes which manufacturers are considering acquiring or operating, (4) surveying the processes of manufacturing companies to determine if they are receiving adequate patent protection, (5) coöperation with manufacturers to obtain extended uses of their products and processes, (6) coöperation with clients and patent attorneys in reviewing technical aspects of the prior art, and (7) reviewing the current technical and patent literature. H.E.S.

PATENTS

Ceramic composition. ANDREW MALINOVSZKY. U. S. 2,106,410, Jan. 25, 1938 (Jan. 18, 1936).

Ceramic glazing composition. E. R. STOWELL (Worthington Hoyt). U. S. 2,106,879, Feb. 1, 1938 (June 19, 1936). A process of making a "slip" for glazing ceramics comprises bringing together a major portion of finely divided silicon carbide with a small proportion of finely divided silica and a small proportion of a sodium silicate compound of relatively low viscosity and water, allowing the silica to react with the silicate, and finally adding a sodium silicate compound of relatively high viscosity and water sufficient to reduce the mass to a suitable consistency for brushing, spraying, or dipping.

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Mon. Phys. Phys.-Chem. Glass (Moscow)
Nachrichten von der Gesellschaft der Wissenschaften zu Göttingen, Jahresbericht über das Geschäftsjahr, Mathematisch-physikalische Klasse
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Nauchnye Zapiski po Sakharnoĭ Promyshlennosti
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